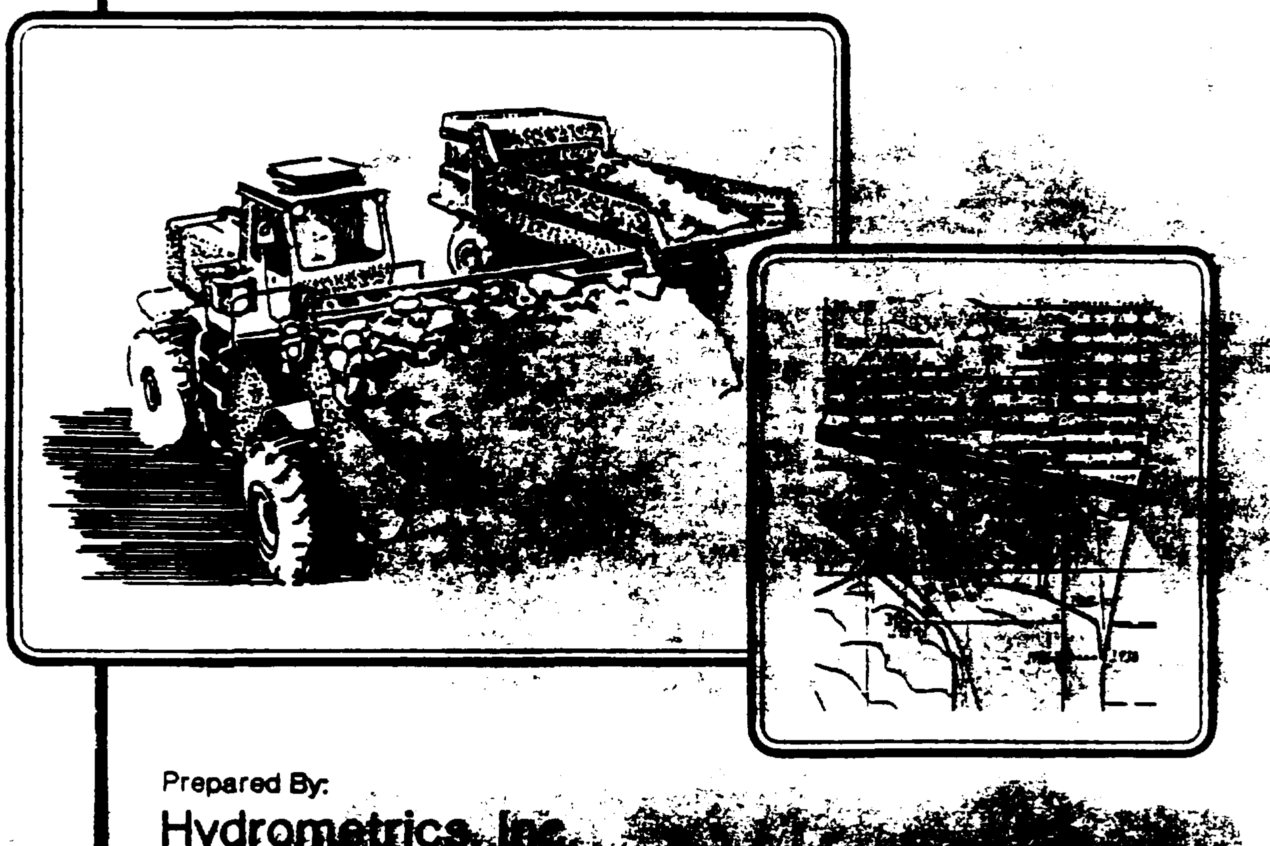
Work Plan For Excavation And Removal Of Residential Soils East Helena, Montana

Prepared For:

ASARCO Incorporated

East Helena, Montana



Prepared By:

Hydrometrics, Inc.

Consulting Scientists and Engineers

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2405

Ref: 8RC

Steve Siegel, Esq.
U.S. Environmental Protection Agency
Region V
230 S. Dearborn
Chicago, Illinois 606604

Dear Steve:

Enclosed please find a copy of the work plan for the East Helena Residential Soils Removal Action. EPA's project coordinator for this site is Scott Brown. Scott can be reached at FTS 585-5414.

Please feel free to call me (FTS 330-7531) or Scott if you have any questions about the work plan, or any other aspect of this case. In the meantime, good luck with the NL Industries site.

Sincerely,

Suzanne J. Bohaan
Assistant Regional Counsel

Enclosure

WORK PLAN
FOR EXCAVATION AND REMOVAL OF RESIDENTIAL SOILS
EAST HELENA, MONTANA

Prepared for:

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July 16, 1991

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1.0 INTRODUCTION

A Comprehensive Remedial Investigation/Feasibility Study (RI/FS) report, which addressed all operable units for the entire East Helena site, was submitted by ASARCO Incorporated (Asarco) to the United States Environmental Protection Agency (EPA) on March 30, 1990. The operable units delineated for the East Helena Site as part of the RI/FS are: process fluids, groundwater, surface water/surface soils, slag pile, and the ore storage area*. Comments on portions of the surface water/surface soils operable unit were submitted by EPA to Asarco on February 28, 1991. The primary elements of the surface water/surface soil operable unit addressed in the February comments are:

- East Helena residential soils,
- Wilson Ditch sediments, and
- Vegetation.

A revised RI/FS report for Residential Soils, Wilson Ditch and Vegetation was submitted by Asarco to EPA on March 29, 1991, which was used by EPA to conduct an equivalent to an Engineering Evaluation/Cost Analysis (EE/CA), completed May 1991.

These operable units have recently been consolidated to: The process ponds; groundwater; and surface water, soils and vegetation.

This Work Plan for Excavation and Removal of Residential Soils is based on technical meetings between Asarco, EPA and Montana Department of Health and Environmental Sciences (MDHES). The Work Plan includes plans for a soil removal action starting in summer 1991.

This Work Plan does not address Wilson Ditch sediments. Ditch sediments will be addressed as a separate issue at a future date.

1.1 SITE HISTORY

The Asarco East Helena Plant is located adjacent to Prickly Pear Creek, just south of the community of East Helena (Figure 1-1). The plant, which has operated for over 100 years, recovers base metals from ore concentrates using pyrometallurgical processes. The plant is a primary lead smelter and has also recovered zinc in the recent past.

As part of the East Helena Site RI, several investigation phases have been conducted on plant site source areas, groundwater, surface water and soils. Three soils investigations were conducted including: soil sampling as part of the 1983 child lead study; the Phase I Soils Investigation (EPA 1987) and the soils portion of the Comprehensive RI/FS (Hydrometrics 1990, revised 1991). As part of these three investigation studies, samples were collected from several environmental media including: soils, vegetation, surface water, groundwater, air, animal fluids and tissues, fish tissue, garden vegetables, and others. Samples of blood, hair and urine were also collected from humans in the East Helena area.

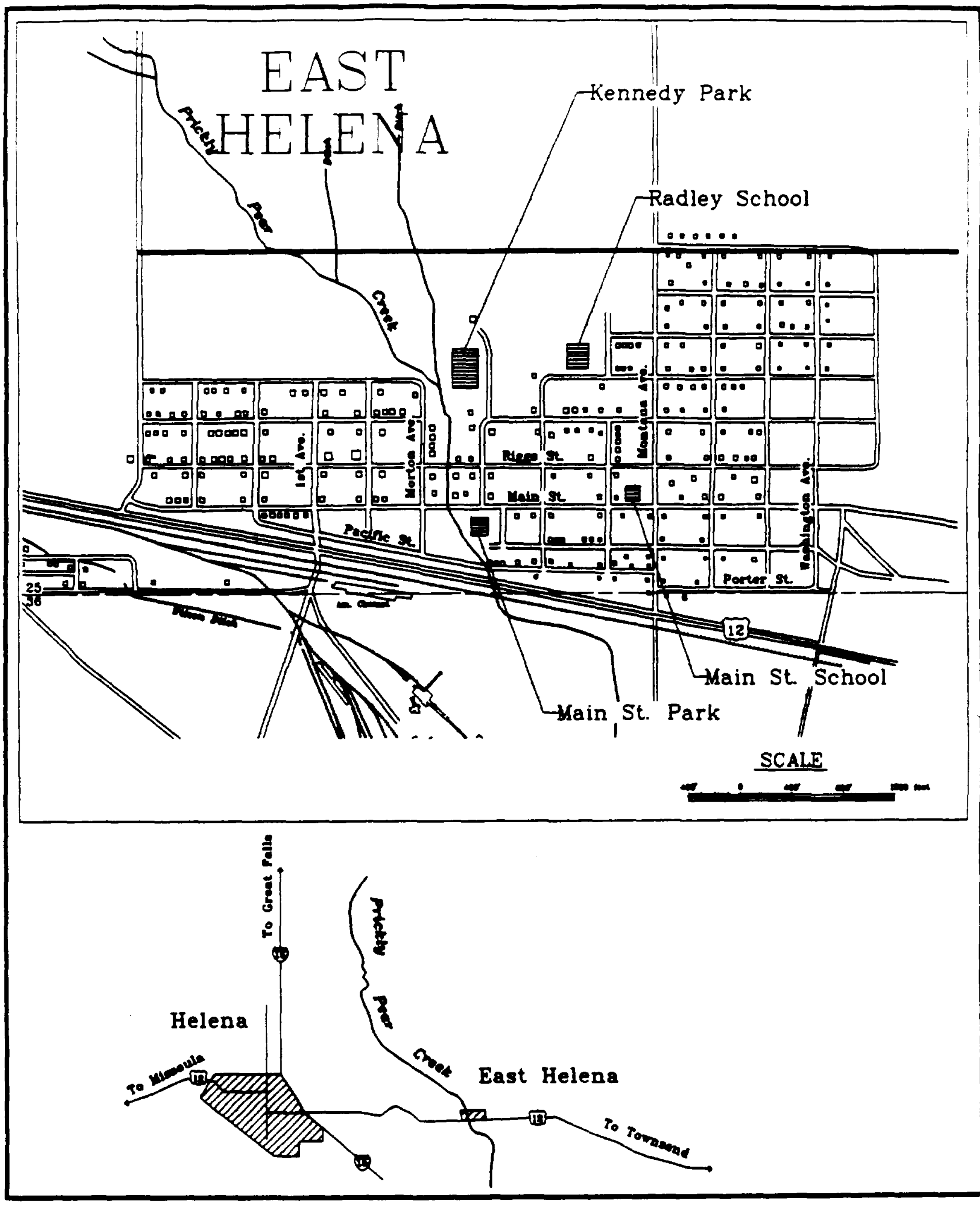

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Figure 1-1. Location Map

The results of these investigations show soils in East Helena have elevated concentrations of lead and other metals, with the highest concentrations nearest the East Helena plant. Other media relative to residential soils, particularly garden vegetables and other vegetation, also had elevated metal parameter concentrations. Results of the 1983 Child Lead Study identified one child as having elevated blood concentrations above 25 micrograms per deciliter (ug/dl) and a zinc protoporphrin level above 35 ug/dl - a clinical symptom of lead toxicity. Today, medical experts express the range of concern for children as 10 to 15 ug/dl. Sixty-six percent of the children who live within one mile of the smelter and were tested in 1983 were within or above the 10 to 15 ug/dl range.

Based on the results of the remedial investigation phases, Asarco and EPA have agreed to a removal action which will address residential yards and public areas.

1.2 METALS AND MIGRATION PATHWAYS

1.2.1 Metal Parameters of Concern

Soil metal parameters with elevated concentrations in residential soils include arsenic (As), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), selenium (Se), silver (Ag), thallium (Tl), tin (Sn), and zinc (Zn). Of these parameters, arsenic, cadmium, copper, iron, lead, manganese and zinc were selected as indicator chemicals in the Endangerment Assessment portion of the Comprehensive RI/FS. The indicator chemicals are selected based on potential health and environmental risks, including: toxicity to humans, their concentrations in various media studied at the East Helena Site, and their mobility and persistence in the environment.

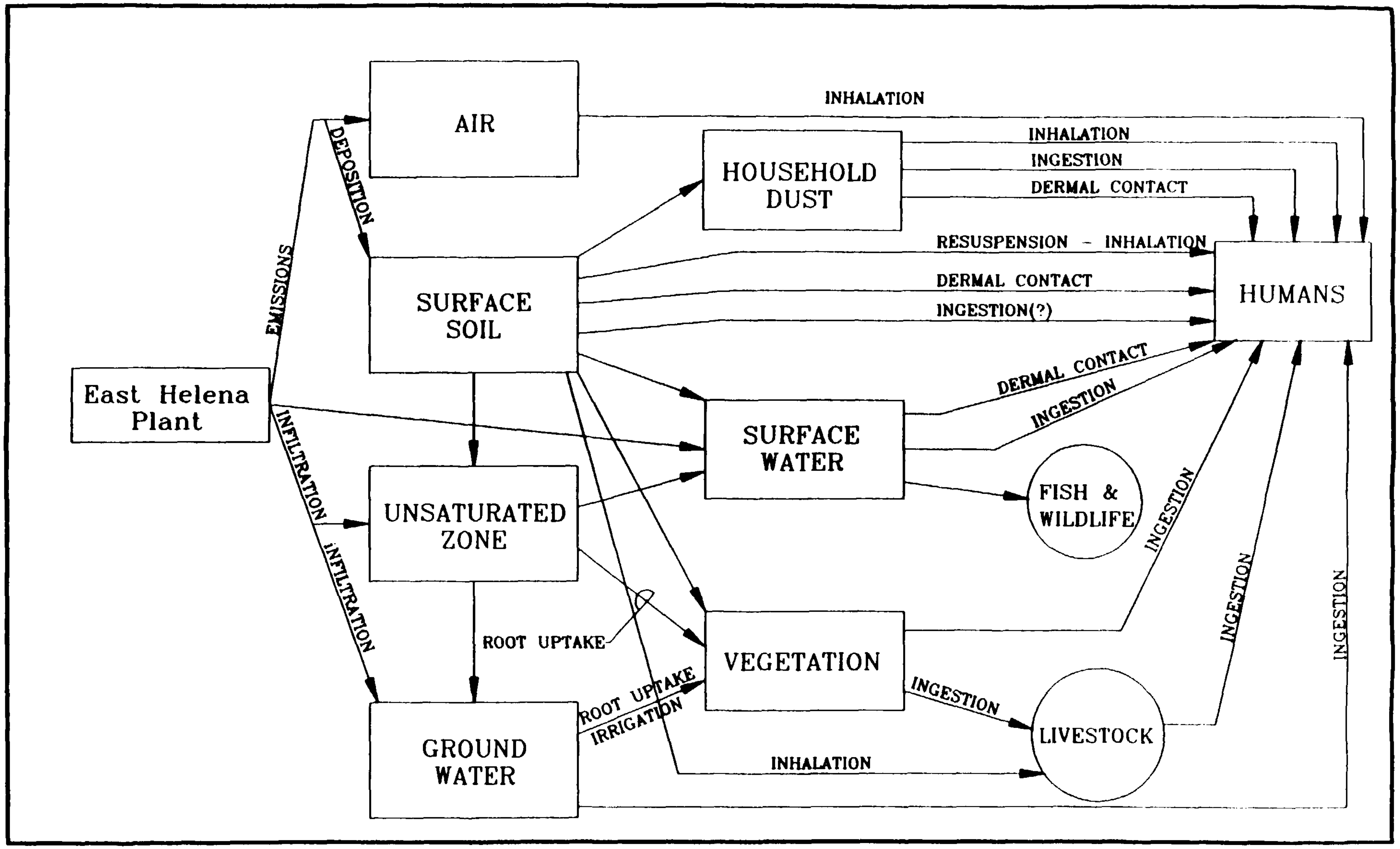
Lead is the primary metal of concern in East Helena residential soils because of its potential health risks to children, and because it has the highest concentrations in community soils. Arsenic and cadmium are additional metals of concern relative to human health. While copper and zinc are not considered significant to human health, these metals are significant in other environmental media (particularly vegetation), and were, therefore, also secondary parameters. Iron and manganese do not, by themselves, pose significant risks to human health or impacts to other environmental media, however, these elements are indicators of the potential mobility of primary and secondary metals of concern in the environment.

1.2.2 Potential Migration Pathways

Potential contaminant migration pathways are studied in detail in the Endangerment Assessment (EA) portion of the Comprehensive RI/FS. The principal pathways within residential East Helena include:

- ingestion of surface soils with elevated metal concentrations;
- inhalation of airborne dust with elevated metal concentrations;
- ingestion of dust; and
- ingestion of vegetables grown in residential soils with elevated metal concentrations.

A conceptual model of principal exposure pathways within East Helena is in Figure 1-2. As this figure shows, residential soil is a source of many subsequent migration pathways including potential exposure from and vegetable gardens. Of the pathways investigated in the EA portion of the Comprehensive



Legend

Primary Contaminant Pathway

Potential Receptor

Figure 1-2. Potential Migration Pathways and Receptors in Residential East Helena

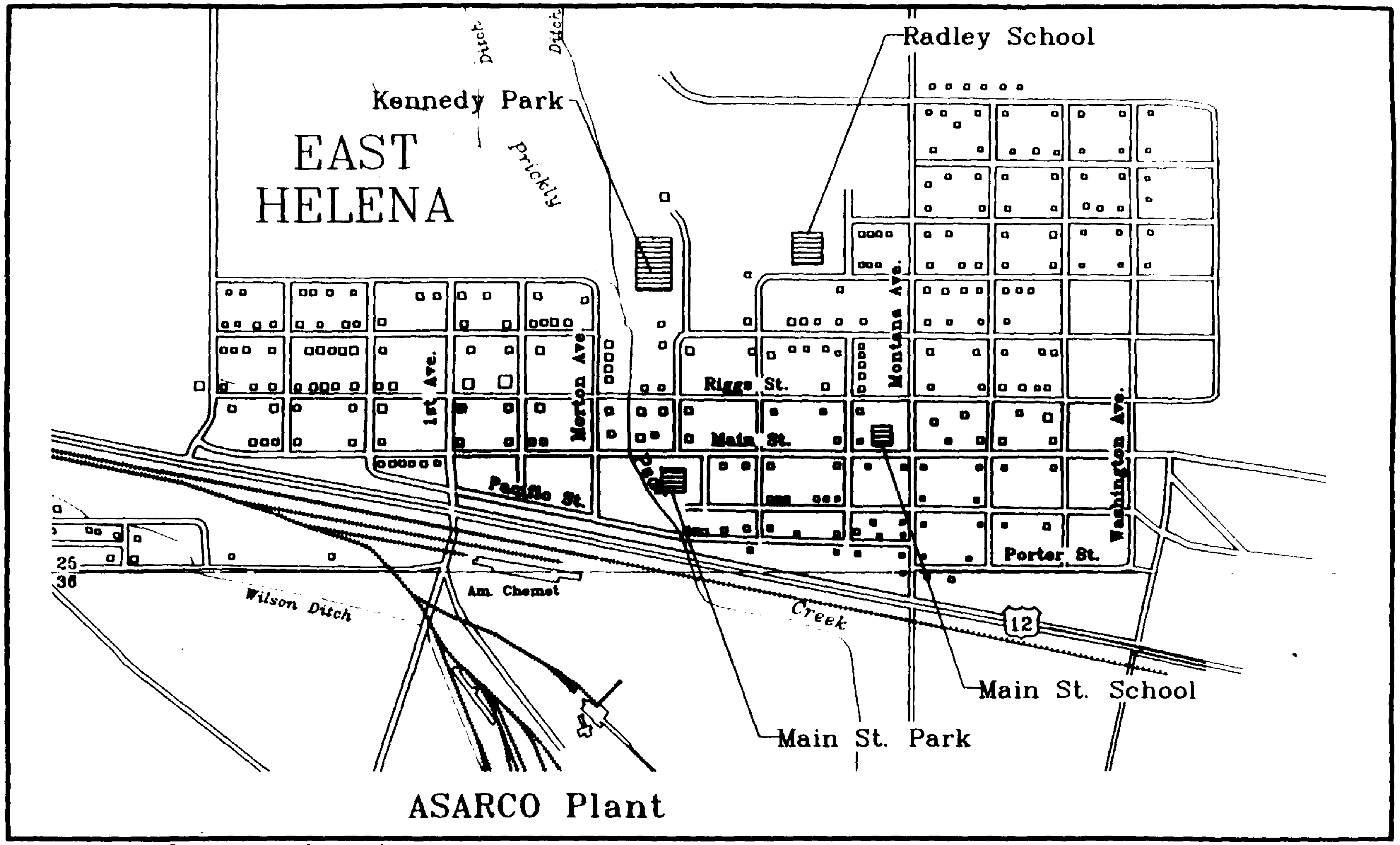
RI/FS, residential soils have been identified as the most significant. Remediation of residential soils will reduce the potential for direct exposure from these soils, and from indirect exposure through subsequent pathways.

1.3 SCOPE OF RESIDENTIAL SOIL REMOVAL ACTION

The EPA policy directive suggests soil lead levels within the range of 500 to 1000 mg/kg may lead to blood lead levels in children greater than the level of concern (10 to 15 ug/dl). Within this blood lead range, adverse health effects may become apparent in children. In an effort to reduce children's blood lead levels below this range of concern, a target soil removal level of 1000 mg/kg will be used.

The scope of the soil removal action will include approximately 246 residential yards, one public park and one public school in an area bounded by First Street, Riggs Street, Washington Avenue and Highway 12 (see Figure 1-3). This area has been referred to as the "yellow zone". Excavated soils will be transported to the "east fields", located east of the Asarco plant, and stockpiled. The residential yards will then be backfilled with clean topsoil and resodded. Soils will also be removed from one park, a schoolyard, vacant lots, and unpaved streets and alleys within the area. Unpaved alleys and streets will be covered with a suitable gravel mix to reduce potential exposure from alley dust.

Soils with lead concentrations exceeding 1000 mg/kg in residential yards, schools, parks and other public areas outside the yellow zone will also be excavated. Residential yards and public areas outside the yellow zone will



Scale: 1" = 800 feet (Approx.)

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Anticipated Soil Removal Zone

Figure 1–3. Anticipated Soil Removal Area be tested using an X-Ray Fluorescence (XRF) spectrometer, to determine if surface soils are above the 1000 mg/kg action level for soil removal.

Surface soils in excess of the 1000 mg/kg action level also will be excavated, transported and stockpiled in the east fields with soils removed from the yellow zone. Based on data collected during the RI, a preliminary estimate of about 75 residences and one school (Radley School, see Figure 1-3) will be addressed by soil removal action outside of the yellow zone.

1.4 WORK PLAN COMPONENTS

General components or elements addressed in this work plan include:

- Soil sample collection programs which consist of:

  1) An initial sampling program to assist in determining a standard depth of soils removal and to calibrate the XRF;

  2) A soil backfill and sod sample program to provide data for selection of sources;

  3) A pre-soil removal soil sampling program;

  4) A post-soil removal soil sampling program.

- Soil sample removal plan including removal protocol and procedures;

- Soil storage plan including transportation and stockpile procedures;

- Assessment of long-term impacts.

Additional elements of this soil removal work plan include:

- Descriptions of the responsibilities and titles of key personnel and/or organizations working on the residential soils project;

Additional documents related to this work plan for residential soil removal include:

- Sampling and Analysis Plan (includes the Field Sampling Plan and a Quality Assurance Project Plan);

- Health and Safety Plan.

2.0 SOIL SAMPLING PROGRAMS

Soil sampling will be an integral part of the soil removal action from residential areas and public areas in East Helena. A portable XRF will be used to analyze soil samples collected before, during and after soil removal. Several phases of sampling will be conducted:

1. The initial sampling program. This program consists of soil sample collection from 60 locations. Four incremental profile samples will be collected from each location and analyzed by XRF for a total of 240 samples. Wet chemistry methods (HF and CLP RAS) will also be conducted on 50 selected samples of the 240 total. Objectives of the initial sampling program are to:

   - Provide samples to calibrate the XRF spectrophotometer;

   - Provide additional data on the depth of elevated metals in residential soils to establish a standard soil removal interval;

   - Obtain additional soil samples which will be archived for potential analyses including metals leachability and mobility testing.

2. Soil backfill and sod sampling program. The objective of this sampling effort is to provide data on metals concentrations and

physical characteristic data necessary for the selection of sources for soil backfill and sod.

3. Pre-removal soil sampling program. The purpose of this sampling effort is to determine which residences, commercial properties, and public areas located outside the yellow zone have soils in excess of 1000 mg/kg. Soils in excess of 1000 mg/kg will be eligible for excavation and replacement.

4. Post-removal soil sampling program. The purpose of this sampling effort is to document soil concentrations which remain after removal of the standard soil interval.

2.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions during remedial response activities. The DQO development process consists of three stages:

1. Identification of decision types;

2. Identification of data uses and needs;

3. Design of the data collection programs.

Data uses have already been identified in Section 2.0. Data needs, which include quality control requirements are discussed in Section 2.1.2. Data collection programs for initial soil sampling, soil backfill and sod source sampling, pre-removal sampling and post-removal sampling are detailed in Sections 2.2, 2.3, 2.4 and 2.5, respectively.

2.1.1 Decision Types

A conceptual model of the soil sampling and soil removal program is shown in Figure 2-1.

The sampling program objective is to provide sufficient data for making decisions during the soil removal process. Decision types associated with the initial sampling program are:

- establish calibration of the XRF to acceptable accuracy;
- determine the standard depth of soil removal to provide protection of human health;
- aid in determining the ultimate disposal of removed soils.

Decision types associated with sampling of soil backfill and sod sources are:

- determination of quality of backfill and sod material;
- select source of sod, considering quality, work efficiency and cost.

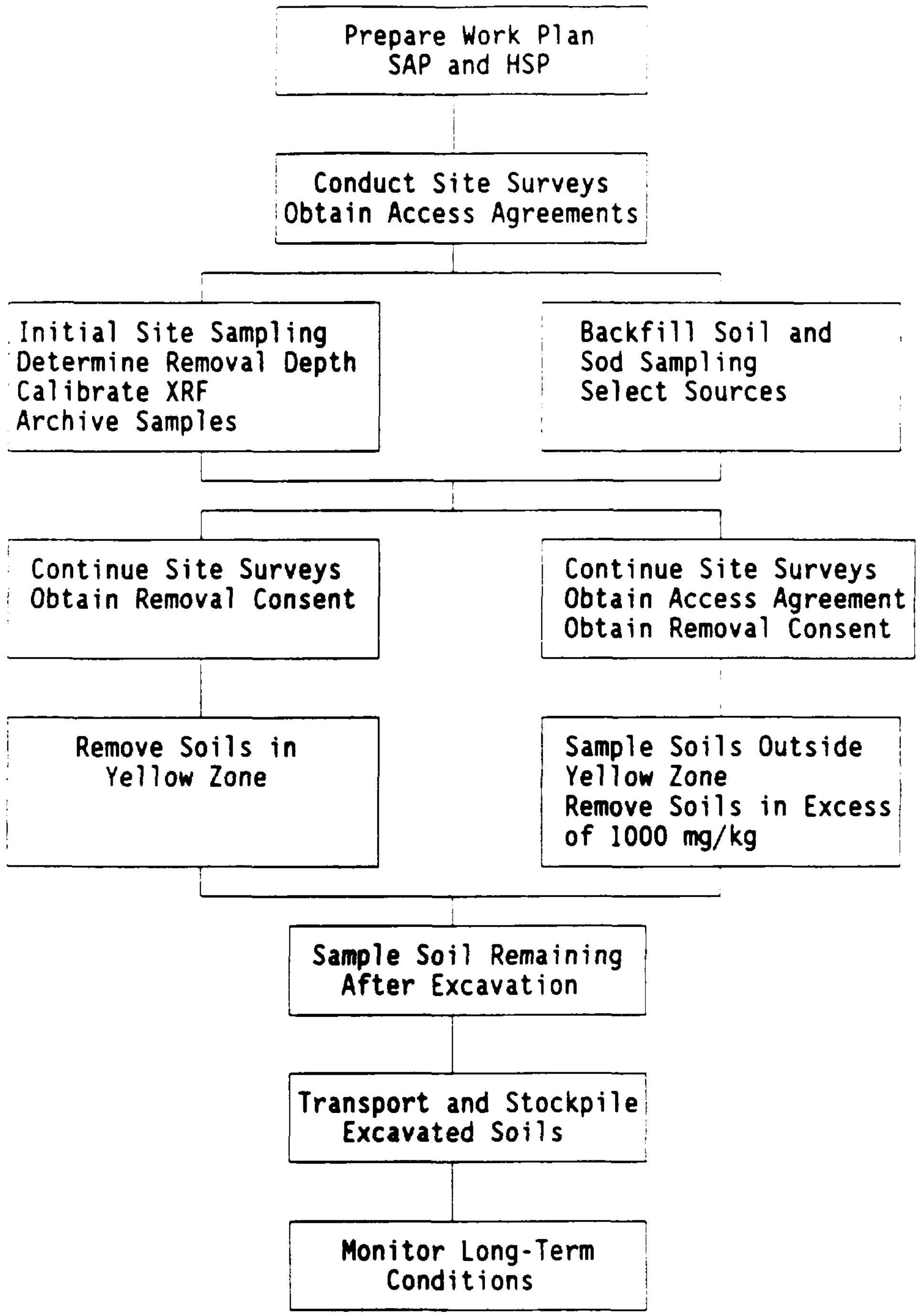


FIGURE 2-1 CONCEPTUAL MODEL OF SOIL REMOVAL PROGRAM

Decision types associated with the pre-removal sample program are:

- determine if soil is to be removed from a given property;

- establish a priority scheme for soil removal;

Decision types associated with the post-removal sample program are:

- determine if a property is sufficiently remediated.

Decisions common to all of the sampling programs include:

- determination of monitoring requirements and potential future land use restrictions.

Primary contacts and data users for the East Helena Soil Removal project are:

<u>Primary Contacts</u>:

D. Scott Brown - USEPA

Greg Mullen - MDHES

Jon Nickel - Asarco

Wil Selser - Lewis and Clark County Health Department

<u>Primary Data Users</u>:

Asarco Contractors

Hydrometrics, Inc.

Removal Personnel

Oversight Personnel

Scott Brown - EPA

Greg Mullen - MDHES

Bill Bluck - CH2M Hill

Steve Mitchell - CH2M Hill

Dick Glanzman - CH2M Hill

Dennis Neuman - MSU

Doug Dollhopf - MSU

Wil Selser - LCCHD

Secondary data users and individuals affected by soil removal actions, agencies and other parties including:

East Helena property owners;

East Helena city government and school district;

Lewis and Clark county government;

Utility companies;

East Helena Citizens' Group;

EPA - Helena Office;

EPA - Region VIII;

2.1.2 Data Needs (Quality Control Requirements)

Soil chemistry data collected by XRF will be used to design and monitor the soil removal process. In order to maximize the accuracy and precision of this technique, the XRF will be calibrated against soil samples analyzed using traditional wet chemistry techniques. A preliminarily calibrated XRF will be used to select samples with lead concentrations ranging from 100 mg/kg to 2000 mg/kg or higher. The preliminary calibration will be conducted using the Fundamental Parameter Correction Method, and/or using previously archived East Helena soil samples. A selection of archived East Helena soil samples with known wet chemistry analytical results is available at the Asarco Department of Environmental Services (DOES) Laboratory, and can be used as pre-calibration standards. Approximately 75% of the samples will have lead levels within the 250 mg/kg to 1250 mg/kg range. Wet chemistry analyses will be conducted using full Contract Laboratory Program (CLP) QA/QC protocols described in the most current CLP analytical Statement of Work (SOW). The metals analyzed will include lead, arsenic and cadmium, which are the parameters most indicative of potential human health risks. Since sample analyses by XRF are nondestructive, the wet chemistry analyses will be conducted on the same sample analyzed by XRF to minimize potential soil variability between sampling techniques.

2.1.2.1 XRF Calibration Model Development

A simple linear correlation and/or multivariate correlation model will be developed for each element analyzed (Pb, Cd and As). The goal is to obtain a calibration model for lead concentrations with an r value (simple linear regression) and/or an R value (multiple regression) exceeding 0.95 in the analytical range between 250 mg/kg and 1250 mg/kg. The 95% confidence limits are to be calculated for lead concentrations for the range of the curve using procedures described in the project SAP.

2.1.2.2 XRF Performance Requirements

XRF instrument performance requirements are:

Precision

Less than 20% Relative Standard Deviation (RSD) at an analytical lead level of 500 mg/kg. This is determined by measuring three subsamples of a sample with a lead concentration near 500 mg/kg. RSD is calculated as the standard deviation/mean x 100.

Accuracy

Measured recovery of a sample with a known lead level near 500 mg/kg within 75-125% of the value or within 95% confidence interval, whichever is smaller.

Limits of Detection

The XRF Limit of Detection (LOD) for each analyte is defined as the lowest concentration level which is determined to be statistically different from the blank (Anal. Chem., 1983) LODs will be calculated as part of the calibration/modeling effort.

2.1.2.3 XRF Quality Control

The following quality control audits are to be integrated into the XRF protocol.

Quality Control Element	Frequency	Limits
Initial Calibration Standard (midpoint)	Beginning of analytical run	Within 75-125% R or 95% of confidence level of known value.
Calibration Standard (midpoint)	One per every 30 samples analyzed	Within 75-125% R or 95% of confidence level of known value.

Quality Control Element	Frequency	LimitsContinuing
Laboratory Duplicate	One per every 20 samples analyzed	20% RSD (=28% Relative Percent Difference (RPD) for N=2), for lead value $\geq$ 500 mg/kg. Unspecified limit for other elements.
Field Duplicate	One for every 20 samples collected	20% RSD (=28% RPD for N=2), for lead value $\geq$ 500 mg/kg. Unspecified limit for other elements.
Reference Material*	One for every 20 samples analyzed	Within limits given by EPA.

* This material may be provided by Reclamation Research Unit (MSU), and/or obtained using archived East Helena soil samples that have been previously analyzed and have known values.

2.1.2.4 **Wet Chemistry Data Quality Needs**

Data quality needs for wet chemistry samples are:

Digestion Methods	Total digestion using multi-mixed acids, including hydrofluoric acid [HF] as referenced by Crock and Severson (1980) or equivalent.
	CLP RAS (Routine Analytical Service) using nitric acid and hydrogen peroxide.
Analytical Methods	Current USEPA CLP SOW for Inorganic Analysis

Analytes and Detection Limits, (ppm)	As(10), Cd(5), Pb(10)
Laboratory Spike Analysis	Frequency: 1/20 samples analyzed Control Limit: 75-125% R Corrective Action: Same as CLP SOW
Laboratory Duplicate Analysis	Frequency: 1/20 samples analyzed Control Limit: 20% RPD for levels > 5 x the required detection limit Corrective Action: Same as CLP SOW
Laboratory Control Sample	Frequency: 1/20 samples analyzed Control Limit: 80-120% R or within established control limits
Additional Control Samples	ICV/CCV, ICB/CCB, Preparation Blanks, Serial Dilution Analysis, ICP Interference analysis etc. In accordance with the Laboratory QC Program described in the current CLP SOW

2.1.2.5 XRF Post-Calibration Sample Quality Control Requirements

Post-calibration sample quality control requirements for XRF sampling are the same as those described in Sections 2.1.2.2 and 2.1.2.3. In addition to these requirements, one sample in 50 will be submitted for confirmational analysis using wet chemistry techniques to provide a continuous check of the XRF technique. A statistical evaluation of confirmational data against XRF data will be conducted using paired t-test, regression analyses and bias calculations. These statistical methods are described in detail in the Sampling and Analysis Plan (SAP).

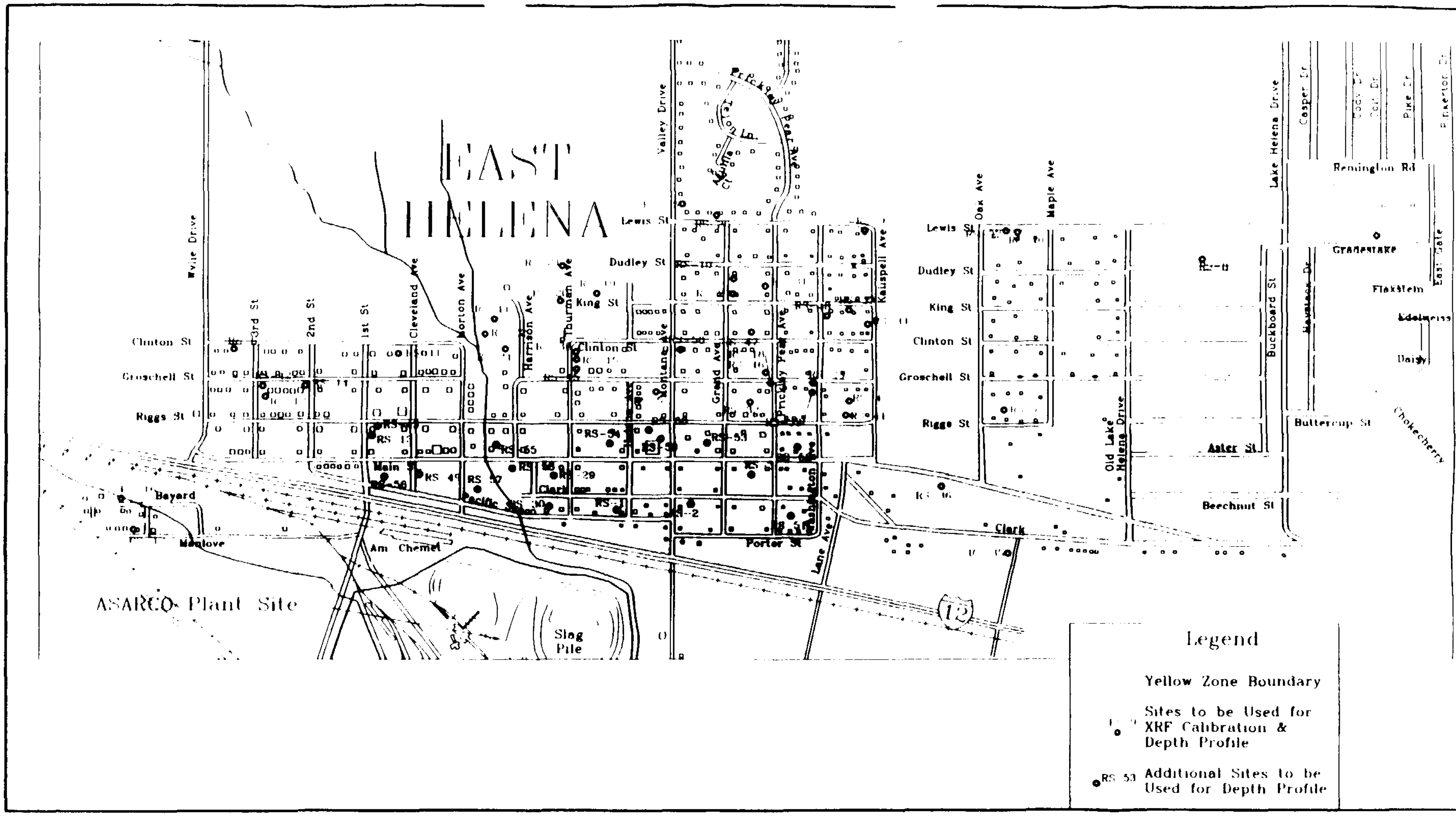
2.2 INITIAL SOIL SAMPLING PROGRAM

A total of 240 soil profile samples at 60 sites (4 sample intervals per site) will be collected. The sample site surface soils will range between 100 mg/kg to 8000 mg/kg with at least 75% of these surface soils within the 250 to 1250 mg/kg range. In addition, at least 20 residential yards, 5 unpaved alleys or roadways and 5 public use areas will be selected for the sampling site locations.

Based on a review of existing data bases including the child lead study (1983) and the Comprehensive RI/FS (1990), preliminary sample site locations have been selected. These preliminary sites are shown on Figure 2-2. A site location evaluation matrix, which compares existing child lead study and RI data, and selected sample sites is in Table 2-1.

A total of 50 sample sites (RS-1 to RS-50, see Table 2-1 and Figure 2-2) will be used to collect surface soil samples (0 to 1 inch) for calibration of the XRF. At these 50 sites, deeper intervals (1-4 inches, 4-8 inches and 8-15 inches) will also be sampled to provide data to assess the standard removal depth guidelines.

An additional 10 sites (RS-51 to RS-60) will be sampled from 0-1 inch, 1-4 inches, 4-8 inches and 8-15 inches to provide sufficient soil chemistry profile data from within the yellow zone. These additional 10 sites are con-



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Scale 1" = 800 feet
Figure 2-2 Initial Soil Sampling Sites

Table 2-1 INITIAL SOIL SAMPLING LOCATION EVALUATION MATRIX

SAMPLE SITE NUMBER	SAMPLE LOCATION	ANTICIPATED SURFACE SOIL Pb WITHIN THE 75% CONCEN. RANGE 250-1250 (mg/kg)	ANTICIPATED SURFACE SOIL Pb WITHIN THE 100% CONCEN. RANGE 100-8000 (mg/kg)	ADJACENT RI SITE/ CONCEN. (mg/kg) (1)	ADJACENT CDC SITE/ CONCEN. (mg/kg) (2)
RS-1	Residential Yard		2500	1012 3950	9 1385
RS-2	Residential Yard		2100	1004 2158	2 2003
RS-3	Residential Yard		1500	1240 1245	240 2647
RS-4	Residential Yard	800		1019 1035	32 625
RS-5	Residential Yard		2300	2082 1130	173 3415
RS-6	Residential Yard		200	1218 246	218 143
RS-7	Residential Yard	300		2108 316	322 252
RS-8	Residential Yard	260		2118 246	120 286
RS-9	Residential Yard	350		2105 482	51 236
RS-10	Residential Yard	550		1037 578	203 507
RS-11	Residential Yard		7000	1076 7225	76 81
RS-12	Residential Yard	1000		1014 995	14 1086
RS-13	Residential Yard	1000		1059 1160	59 866

Table 2-1 (continued) INITIAL SOIL SAMPLING LOCATION EVALUATION MATRIX

SAMPLE SITE NUMBER	SAMPLE LOCATION	ANTICIPATED SURFACE SOIL Pb WITHIN THE 75% CONCEN. RANGE 250-1250 (mg/kg)	ANTICIPATED SURFACE SOIL Pb WITHIN THE 100% CONCEN. RANGE 100-8000 (mg/kg)	ADJACENT RI SITE/ CONCEN. (mg/kg) (1)	ADJACENT CDC SITE/ CONCEN. (mg/kg) (2)
RS-14	Residential Yard	500		2054 225	14 1086
RS-15	Residential Yard	675		1055 788	55 560
RS-16	Residential Yard	350		1050 495	50 287
RS-17	Residential Yard		150	2040 134	
RS-18	Residential Yard	1200		1043 1203	43 1155
RS-19	Radley School	750		2063 742	
RS-20	Radley School		2100	1200 2118	
RS-21	Radley School	1150		1300 1160	
RS-22	Kennedy Park	1000		2064 230	134 1297
RS-23	Residential Yard	600		2093 630	39 586
RS-24	Kennedy Park	1000		2064 230	134 1297
RS-25	Residential Yard	300			185 300
RS-26	Residential Yard	300			299 279
RS-27	Residential Yard	600		2109 378	252 819

Table 2-1 (continued) INITIAL SOIL SAMPLING LOCATION EVALUATION MATRIX

SAMPLE SITE NUMBER	SAMPLE LOCATION	ANTICIPATED SURFACE SOIL Pb WITHIN THE 75% CONCEN. RANGE 250-1250 (mg/kg)	ANTICIPATED SURFACE SOIL Pb WITHIN THE 100% CONCEN. RANGE 100-8000 (mg/kg)	ADJACENT RI SITE/ CONCEN. (mg/kg) (1)	ADJACENT CDC SITE/ CONCEN. (mg/kg) (2)
RS-28	Residential Yard	260		2132 254	141 262
RS-29	Unpaved Alley or Rd		1600	1004 2153	249 1273
RS-30	Unpaved Alley or Rd		3000	1012 3950	62 2340
RS-31	Unpaved Alley or Rd	500		1037 538	105 468
RS-32	Unpaved Alley or Rd	1200		1240 1245	43 1155
RS-33	Unpaved Alley or Rd	350		1058 330	58 406
RS-34	Residential Yard	350		1058 330	58 406
RS-35	Commercial Yard	400		2107 405	
RS-36	Commercial Yard	300		1046 310	
RS-37	Residential Yard	550		1037 578	203 507
RS-38	Residential Yard	675		1055 788	55 560
RS-39	Residential Yard	600		2093 630	39 586
RS-40	Residential Yard	600		2109 378	252 819
RS-41	Residential Yard	800		1019 1035	32 625

Table 2-1 INITIAL SOIL SAMPLING LOCATION EVALUATION MATRIX
(continued)

SAMPLE SITE NUMBER	SAMPLE LOCATION	ANTICIPATED SURFACE SOIL Pb WITHIN THE 75% CONCEN. RANGE 250-1250 (mg/kg)	ANTICIPATED SURFACE SOIL Pb WITHIN THE 100% CONCEN. RANGE 100-8000 (mg/kg)	ADJACENT RI SITE/ CONCEN. (mg/kg) (1)	ADJACENT CDC SITE/ CONCEN. (mg/kg) (2)
RS-42	Residential Yard	1000		1014 995	14 1086
RS-43	Residential Yard	1000		1059 1160	59 866
RS-44	Kennedy Park	1000		2064 230	134 1297
RS-45	Residential Yard	750		1055 788	
RS-46	Residential Yard	1200		1043 1203	43 1155
RS-47	Residential Yard	500		1037 578	257 489
RS-48	Residential Yard	800			845
RS-49	Residential Yard		3500	1011 3900	11 3011
RS-50	Residential Yard		3425	1173 3450	173 3415
RS-51*	Residential Yard	Yellow Zone			
RS-52*	Residential Yard	Yellow Zone			
RS-53*	Residential Yard	Yellow Zone			
RS-54*	Residential Yard	Yellow Zone			
RS-55*	Residential Yard	Yellow Zone			

Table 2-1 INITIAL SOIL SAMPLING LOCATION EVALUATION MATRIX
(continued)

SAMPLE SITE NUMBER	SAMPLE LOCATION	ANTICIPATED SURFACE SOIL Pb WITHIN THE 75% CONCEN. RANGE 250-1250 (mg/kg)	ANTICIPATED SURFACE SOIL Pb WITHIN THE 100% CONCEN. RANGE 100-8000 (mg/kg)	ADJACENT RI SITE/ CONCEN. (mg/kg) (1)	ADJACENT CDC SITE/ CONCEN. (mg/kg) (2)
RS-56*	Commercial Yard	**Yellow Zone**			
RS-57*	Public Area	**Yellow Zone**			
RS-58*	Public Park	**Yellow Zone**			
RS-59*	Residential Yard	**Yellow Zone**			
RS-60*	Public School	**Yellow Zone**			

Calibration Sampling Totals:

37 Residential Yards
6 Public Areas (3 Schools, 3 Parks)
5 Unpaved Alleys or Roadways
2 Commercial Yards

38 within the 250-1250 mg/kg Soil Concentration Range
13 within the 250-500 mg/kg Soil Concentration Range
12 within the 500-750 mg/kg Soil Concentration Range
11 within the 750-1000 mg/kg Soil Concentration Range
11 within the 1000-1250 mg/kg Soil Concentration Range

* Samples collected to provide sufficient coverage in the yellow zone to determine Standard Removal Depth. Selected samples may be used for XRF calibration.

1 RI soil sample data collected in 1984 by EPA and 1987 by Asarco.

2 Soil sample data collected during the 1983 child lead study.

sidered necessary because most of the 50 calibration sites are located in relatively low Pb concentration areas, outside the yellow zone (see Figure 2-2).

Preliminary soil sampling sites shown on Figure 2-2 are approximate and will be refined based on information from property owner surveys and the ability to obtain property access agreements. No sampling will be conducted until property owners' surveys have been completed and access agreements have been obtained.

After property owner access is obtained, samples will be collected using procedures outlined in Section 2.2.1. Factory calibration procedures (Fundamental Parameter Correction), and/or available archived East Helena soil samples will be used to initially "set up" the XRF to approximate soil lead concentrations of collected samples. Based on preliminary XRF screening, approximately 50 soil samples at various depths will be selected to obtain lead concentrations that are within the desired calibration range and are representative of various soil matrices.

2.2.1 Initial Field Sampling Program and Field Sampling Procedures

The initial soil sample collection matrix is in Table 2-2. This table shows estimates of natural field samples, field QC samples (field duplicates, field blanks, and blind field standards) and analytical requirements associated with the initial sampling program.

Initial soil samples will be collected from small pits excavated with hand tools (see Figure 2-3). Samples will be collected from the vertical pit wall

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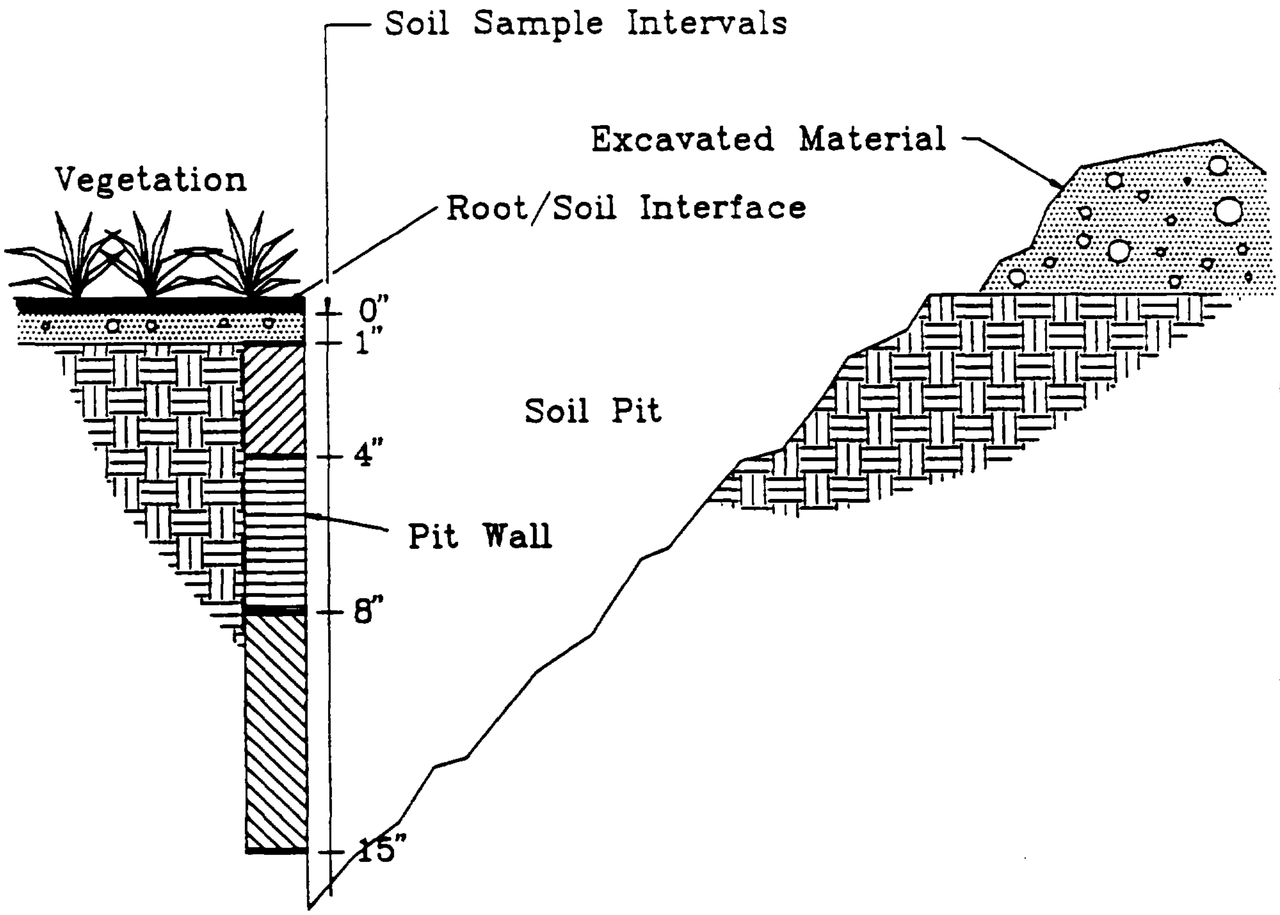
Table 2-2 INITIAL SOIL SAMPLE COLLECTION MATRIX

LOCATION TYPE	PURPOSE	NUMBER OF SAMPLE SITES	SITES W/ SURFACE Pb 250-1250 mg/kg	SITES W/ SURFACE Pb 100-8000 mg/kg	NUMBER OF NATURAL SAMPLES PER SITE	SAMPLE* INTERVAL/ LOCATION (inches)	ANALYTICAL PARAMETER LIST	ANALYTICAL METHODS *	FIELD DUPLICATES	FIELD BLANKS **	BLIND FIELD STANDARDS
Residential Yards	XRF Calibration & Depth Standard For Removal	37	28	9	4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF, HF, CLP RAS XRF XRF XRF	1/20 1/20 for all depths below 1 inch	1/20 1/20 for all depths below 1 inch	1
	Supplemental Yellow Zone Samples to Assess Depth Standard For Removal	6		6	4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF XRF XRF XRF	1/20 samples collected at all intervals	1/20 samples collected at all intervals	
Unpaved Alleys and Streets	XRF Calibration & Depth Standard For Removal	5	5		4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF, HF, CLP RAS XRF XRF XRF	1/20 1/20 for all depths below 1 inch	1/20 1/20 for all depths below 1 inch	1
Public Areas (Parks and schools)	XRF Calibration & Depth Standard For Removal	6	5	1	4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF, HF, CLP RAS XRF XRF XRF	1/20 1/20 for all depths below 1 inch	1/20 1/20 for all depths below 1 inch	1
	Supplemental Yellow Zone Samples to Assess Depth Standard For Removal	3		3	4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF XRF XRF XRF	1/20 samples collected at all intervals	1/20 samples collected at all intervals	
Commercial Yards	XRF Calibration & Depth Standard For Removal	2	2		4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF, HF, CLP RAS XRF XRF XRF	1/20 1/20 for all depths below 1 inch	1/20 1/20 for all depths below 1 inch	
	Supplemental Yellow Zone Samples to Assess Depth Standard For Removal	1		1	4	0-1 1-4 4-8 8-15	As, Cd, Pb for all intervals	XRF XRF XRF XRF	1/20 samples collected at all intervals	1/20 samples collected at all intervals	
TOTAL		60	40	20	240				3 HF, 3 RAS 12 XRF	3 HF, 3 RAS	3 HF, 3 RAS 3 XRF

ANALYTICAL TOTALS INCLUDING FIELD QC SAMPLES	XRF	HF	CLP RAS
	255	59	59

* Alternate intervals other than 0-1 inch may be selected for analysis by HF or CLP RAS based on preliminary XRF screening and based on soil variability.

** Analysis of field blanks will be conducted on HF and CLP RAS samples only. Blanks will not be analyzed by XRF.



SOIL PIT SCHEMATIC

No Scale

Technical Note: The top of the soil profile is defined as that interface between mineral soil and the root mat. Once this separation is made, fine inorganic particles may be woven into the root mat. These fine particles shall be retrieved by dry sieving the root mat on a 10 mesh screen. Particles passing this screen shall be included in the minus 10 mesh save sample.

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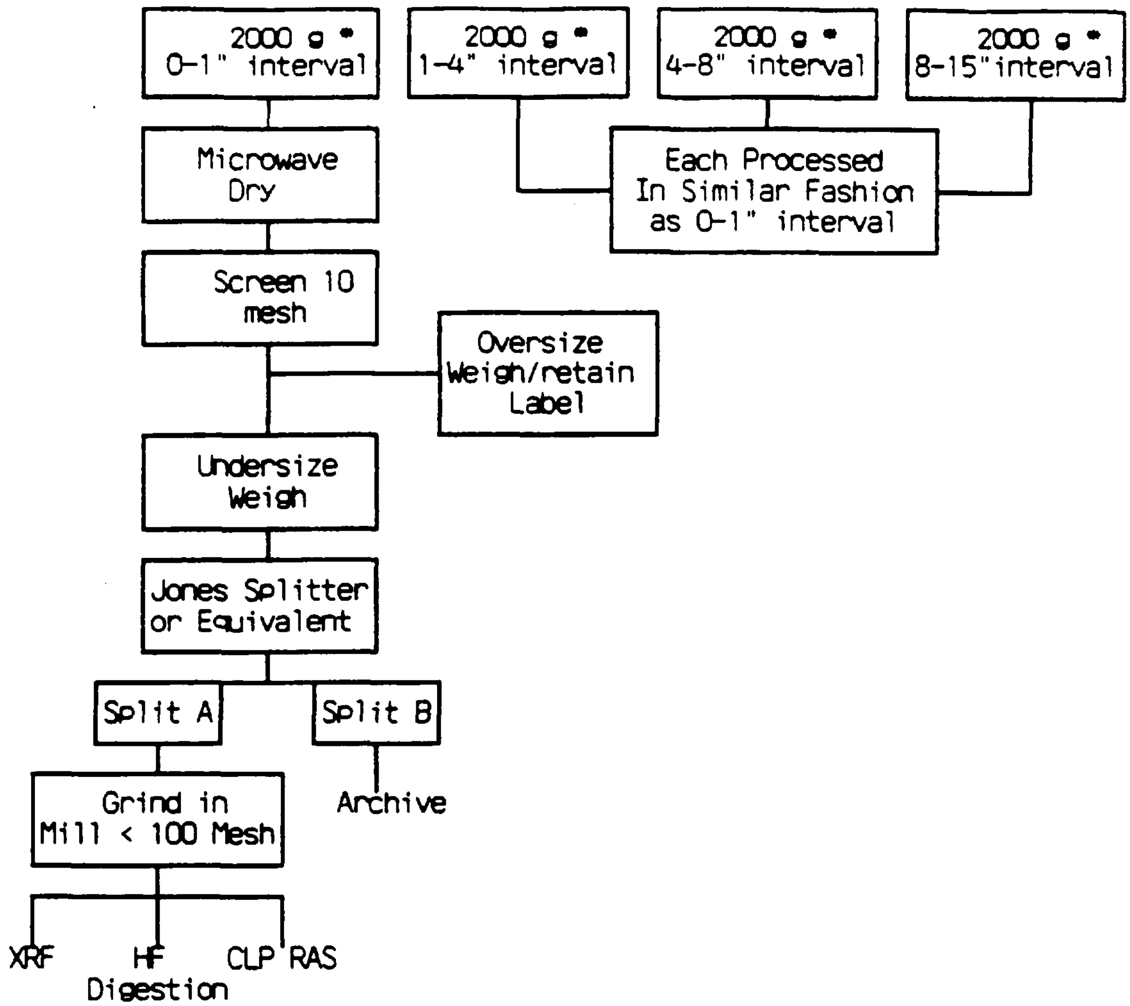
Figure 2-3.
Soil Sample Pit Schematic

only; excavated materials from the pit itself will not be sampled. Approximately 2000 grams of gravel-free (less than 2.0 millimeters in diameter) soil will be collected from each soil sample horizon. Most of the 2000 gram sample will be archived. Where sampling conditions are difficult (i.e., large rocks and cobbles prohibit easy collection of samples), a minimum of 200 grams of soil will be collected from a horizon. Two hundred grams is the minimum sample to meet analytical requirements. Samples will be collected using non-contaminating hand tools in accordance with Standard Operating Procedures (SOPs) presented in the SAP. After sampling is completed, the pits will be backfilled and sod salvaged from the excavation will be replaced. If necessary, new sod will be imported if adequate sod cannot be salvaged. Sampling procedures, including field documentation requirements, are discussed in detail in the SAP.

Each sample interval will be double-bagged in gallon size zip-lock heavy duty freezer bags, and labeled in accordance with SOPs presented in the SAP. Bagged samples will then be transported to the sample preparation area.

2.2.2 Pre-analysis Soil Sample Preparation

A pre-analysis sample preparation schematic diagram is in Figure 2-4. For the initial sampling campaign, sample preparation and handling will be conducted at the Asarco Department of Environmental Services Laboratory (DOES). Sample preparation and handling associated with subsequent sampling conducted as part of the removal action will be conducted in a field laboratory located near the city of East Helena.



* Target sample size will be 2000 grams.
If difficult sample conditions exist
(rocks, boulders, hardpan, etc.) a
smaller sample size may be collected.
200 grams is the minimum sample size necessary
to meet analytical requirements.

Figure 2-4. Initial Soil Sample Prepartion and Handling

Sample preparation will include drying in a microwave, disaggregation, and mill grinding to less than 100 mesh. A Jones sample splitter, or equivalent will be used to create 2 homogeneous samples from each sample interval. The first and second splits will be labeled A and B, respectively.

2.2.3 Sample Analytical Program

Split A will be used for XRF analysis and for total element analysis (HF digestion and analyzed by ICP or AA) after XRF analyses have been performed. A portion of split A will also be analyzed using CLP RAS techniques (citric acid and hydrogen peroxide digestion, and analyzed by ICP or flame AA). Based on preliminary XRF screening (see Section 2.2), 50 soil samples will be selected for total element analysis (HF digestion) for XRF calibration. Alternate sample intervals (1 to 4 inches, 4 to 8 inches or 8 to 12 inches), may be selected for HF digestion based on the preliminary XRF screening analyses of surface (0-1 inch) samples and based on an examination of soil variability. The selected 50 samples will also be analyzed using CLP RAS procedures. Split A samples not selected for analysis by HF digestion and CLP RAS analyses will be archived after analysis by XRF.

Split B will be properly labeled and archived. These samples will be available for any future analytical programs including leachate testing, if necessary. Five samples will be selected for analysis using the leachate testing procedure; leachate samples will be selected at a later date based on calibration testing results. Samples with relatively high concentrations ranging from about 500 to 5000 mg/kg will be selected.

Future testing will be conducted in accordance with EPA Testing Procedures 1312. This procedure more closely approximates expected conditions of the soil stockpile environment than other testing procedures such as TCLP or EP toxicity.

Based on the standard removal depth guideline to be selected for soil removal (anticipated to be 6 to 8 inches), depth composite samples (0-6" or 0-8"), which are representative of excavated soils will be analyzed by leachate test method EPA 1312.

The initial sampling laboratory program is summarized in Table 2-3. An estimated total of 334 XRF samples, including quality control samples, will be analyzed. In addition, 166 samples (including quality control samples) will be analyzed using HF, and CLP RAS methods.

2.2.4 Calibration Model Development

Simple and/or multivariate regression models will be developed for lead, the primary analyte for East Helena residential soils. The goal is to obtain a calibration where the r value (simple linear regression) and/or the R value (multivariate) regression exceeds 0.95 in the analytical range between 250 mg/kg to 1250 mg/kg. Models will also be developed for cadmium and arsenic.

In addition, the 95% confidence limits for lead concentrations will be calculated for the calibration curve by using the least squares estimation of the error variance. A detailed description of simple and multivariate calibration model development and calculation of 95% confidence limits is in Appendix 1.

Table 2-3 LABORATORY ANALYTICAL PROGRAM

SAMPLE SPLIT	PURPOSE	ANALYTICAL PARAMETERS	ANALYTICAL METHODS	NUMBER OF NATURAL SAMPLES	NUMBER OF FIELD QC SAMPLES	LABORATORY DUPLICATES	LABORATORY BLANKS	CONTROL STANDARDS	SPIKES	ICVs	CCVs	ICBs	CCBs	TOTALS
A	XRF Calibration & Depth Standard For Removal	As, Cd, Pb	XRF	240	15	13	0	13	13	2	9	--	--	305
		As, Cd, Pb	HF	50	9	3	3	3	3	1	5	1	5	83
		As, Cd, Pb	CLP RAS	50	9	3	3	3	3	1	5	1	5	83
B	Archive for Selected Leachate Testing	As Ba, Cd, Cr, Pb, Hg, Se, Ag	EPA 1312	5	--	1	1	1	1	1	1	1	1	13
TOTALS				345	33	20	7	20	20	5	20	3	11	484

2.2.5 Determination of Standard Soil Removal Depth

Each of the sixty initial soil samples will be separated into four depth intervals, with two sample splits obtained from each depth interval. A total of 240 samples, one for each depth interval, will be analyzed by XRF for Pb, As, and Cd. XRF analysis is the only analysis to be performed as the XRF is now calibrated to curves based on HF digestion. XRF analyses from about 50 selected samples used to calibrate the XRF will be used for this data base; however, the correction factor based on the calibration curve will first be applied. Although the XRF will measure arsenic and cadmium, the standard removal depth will be a dependent on lead concentrations.

The standard removal depth guideline of East Helena residential soils will be developed based on a statistical evaluation of the XRF analyses of soil samples from various depths. XRF analyses will be arranged as follows:

XRF ANALYSES (Pb)

Soil Depth	# of Samples	Mean	Std. Dev.	L95	U95
0-1"	60	*	*	*	*
1-4"	60	*	*	*	*
4-8"	60	*	*	*	*
8-15"	60	*	*	*	*

* dependent on statistical evaluation of lab analyses

$$\text{Sample Mean } (\bar{X}) = \sum_{i=1}^{n} \frac{X_i}{n}$$

where n = number of samples and Xi = lead analyses

Standard deviation of samples $(\hat{S})=$

$$\sqrt{\frac{\sum(X-\bar{X})^2}{n}}$$ where X = lead analyses

$\bar{X}$ = sample mean

n = # of samples

Standard deviation of population $(\sigma) = (\hat{S})$. Since the number of samples is sufficiently large ($\geq$ 30), it is assumed the standard deviation of the samples is an approximation of the standard deviation of the population, i.e., East Helena residential soils.

Standard deviation of sample means $(\sigma_{\bar{x}}) = \frac{\sigma}{\sqrt{n}}$

Z-value (standard deviation units): referencing a table showing areas under the Normal Probability Curve, the z-value at the upper limit of the 95% data distribution gives an area under the normal curve equal to (1/2), (0.95) or 0.475. The area of 0.475 corresponds to a z-value of $\pm$ 1.96.

U95 = Upper 95% confidence limit

L95 = Lower 95% confidence limit

$(\sigma_{\bar{x}})(+z) = U95 - \bar{X}$

$(\sigma_{\bar{x}})(-z) = L95 - \bar{X}$

The sample mean (average) lead concentration will be calculated from individual sample analyses. Through statistical analysis of the sample mean, 95% confidence limits will be calculated for the mean lead concentrations in East Helena residential soil horizons (depth intervals).

The standard soil removal depth will be based on the upper 95% confidence limit for a soil depth interval. For example, if the 4 to 8-inch depth interval is the first interval where the upper 95% confidence limit is less than 1000 ppm, the standard soil removal depth will be between 4 to 8-inches.

The actual soil removal depth will be determined based on a comparison of statistical results and standard excavation equipment performance. For example, typical minimum excavation for front-end loaders is about 6 inches $\pm$ 2 inches.

Example - Given: n = 60 samples from one depth interval (assume 1-4")

$\bar{x}$ = 900 ppm Pb

$\hat{S}$ = 500 ppm, i.e., approximately ⅔ of the samples are in the range of 400 - 1400 ppm.

$\sigma = \hat{S}$

z-value for 95% = ±1.96

Calculations: $\sigma_{\bar{x}} = 65$

$U95 = \bar{x} + (\sigma_{\bar{x}})(+z)$

$U95 = 900 + 128$

$U95 = 1028$ ppm Pb

Based on the preceding statistical analysis, this soil depth interval would require excavation.

2.3 SOIL BACKFILL AND SOD SAMPLING PROGRAM

Backfill soil will be required for residential yards and other areas excavated as part of the removal action. The replacement soil quality criteria and acceptable soil texture ranges are shown in Table 2-4 and Figure 2-5, respectively.

Several potential soil sources will be investigated. These sources include commercial vendors and undeveloped soil property areas which may be potential as sources of large volumes of replacement soil. An investigation of undeveloped soil areas will include a preliminary assessment based on available soils data and literature. Several factors other than criteria shown in Table 2-4 and Figure 2-5 will be evaluated before the sources are selected, including:

- haul distances;
- necessary traffic pattern adjustments;
- costs;
- long-term and short-term availability.

Since several factors in addition to the requirements shown in Table 2-4 and Figure 2-5 require consideration prior to selection of backfill sources, the replacement soil sample program will be conducted in two phases.

<u>Phase I</u>

Five potential soil sources were investigated to determine suitability for use as replacement soils for the East Helena soil remediation work. The investigations were preliminary consisting of test pits excavated for field

TABLE 2-4. REPLACEMENT SOIL REQUIREMENTS

Parameter	Requirement
Particle Size Distribution	
° Texture	See Textural Triangle (Figure 2-5)
° Rock Fragments	Particles >2 mm diameter constitute <20% of sample.
Available Water Holding Capacity	> 1 inch/foot
Saturation Percentage	25% to 80%
pH	>5.5 and <8.5
Specific Conductance	<4000 µmhos/cm
Sodium Adsorption Ratio	<10
Trace elemental levels	Trace element requirements will be evaluated considering project objectives, backfill, haul distance, traffic patterns and costs.
lead	<50 ppm
arsenic	<30 ppm
cadmium	<5 ppm

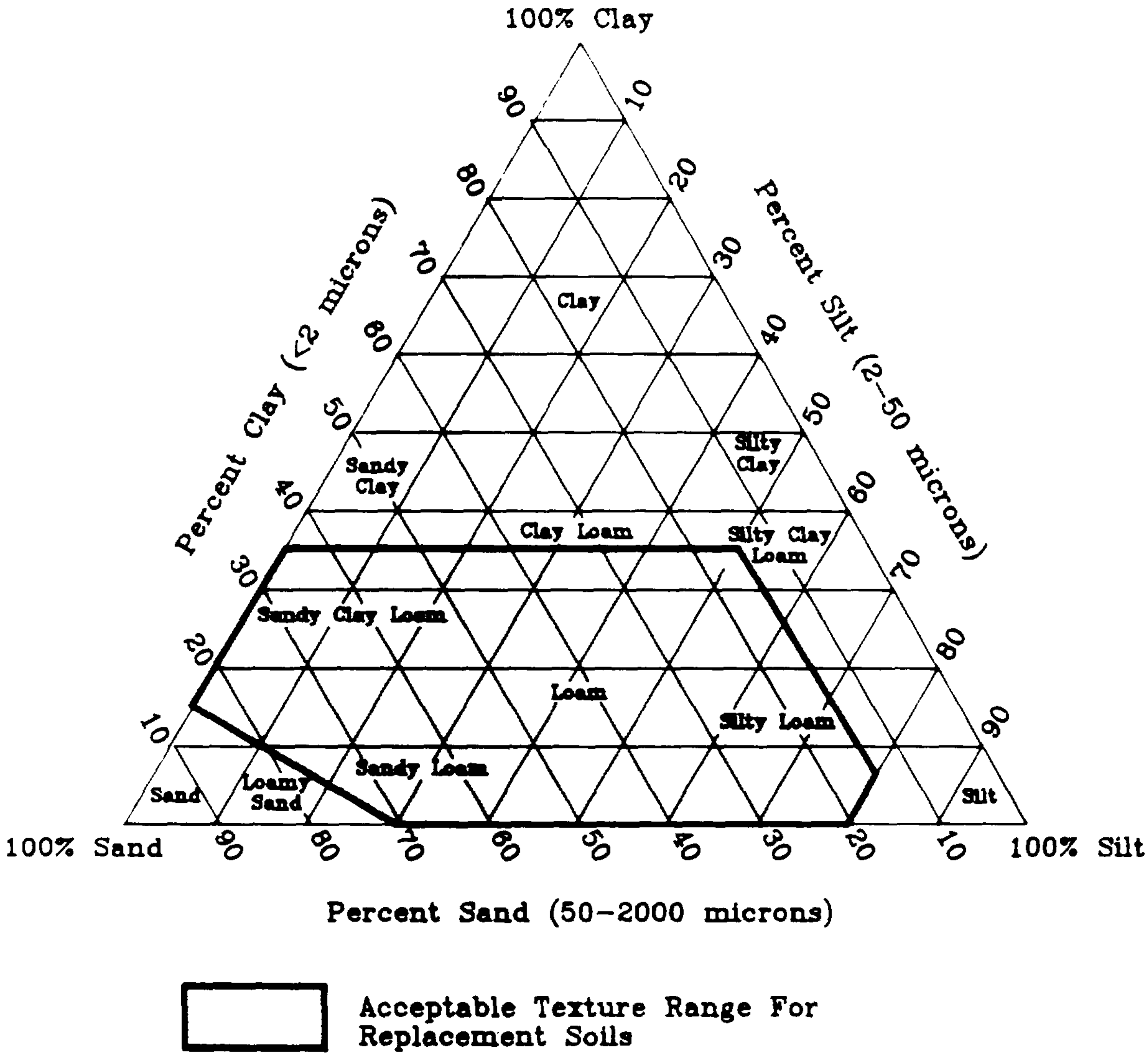


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Figure 2-5.
Acceptable Texture (U.S.D.A.) Range For Replacement Soils

logging of texture, color and horizon depths. One of the test pits was selected as representative of the soil type observed and sampled as follows:

1. The sod was stripped and a sample taken from the 0"-6" depth to be analyzed for metals.

2. A second sample was composited from the soil horizons, to the anticipated depth of removal based upon field sampling, to be analyzed for texture, rock fragments, SAR, water holding capacity, pH, and SC.

This initial sampling was intended to screen some of the sites and determine one or two for detailed (Phase II) sampling and analysis.

Once a site is selected, a stripping plan will be developed in cooperation with the operator, based upon his work schedule and the soil information available. As stripping progresses, additional sampling for field texture and suitable soil depth will be conducted to adjust removal depths, mixing procedures and soil handling to maintain a quality product.

If the potential source is a commercial stockpile, 6 representative samples will be collected. These sample locations will be selected based on survey information and professional judgement.

Grab samples will be collected using standard backhoe equipment or hand tools as appropriate. Backfill source sample standard operating procedures are detailed in the SAP. Samples will be bagged in non-contaminating, heavy-duty gallon zip-lock bags, labelled and sent to the preparation area. Pre-analytical sample preparation procedures are shown in Figure 2-6.

Phase II

A second phase of potential source sampling may be conducted if preliminary source surveys, and Phase I soil sampling results indicate sufficient variability warrants additional sampling. Phase II sampling may be appropriate for large undeveloped sources where the soil characteristics may be less well known than at commercial source stockpiles. If Phase II sampling is considered necessary, the sample number, locations, and intervals will be developed based on site survey information and Phase I sampling results.

The area to be stripped will be blocked out in a manageable size based on soil demands, time and equipment. Three or more test pits will be bored, or excavated to identify soil texture and suitable removal depths for the block. As work progresses, this sequence will be followed for subsequent blocks of work.

In addition to backfill sources, potential sources of sod will also be sampled to determine background trace element levels. The same metal parameters for backfill soils shown on Table 2-4 (lead, arsenic and cadmium) will be analyzed. Three samples will be collected and composited from each selected potential source of sod. Potential sources will be selected based on the same factors as background soils. In addition, sod quality and post-installation performance will be considered. Soil samples from the root mass and litter of potential sod sources will be collected using the same procedure to collect initial samples from the 0 to 1 inch intervals. Fine

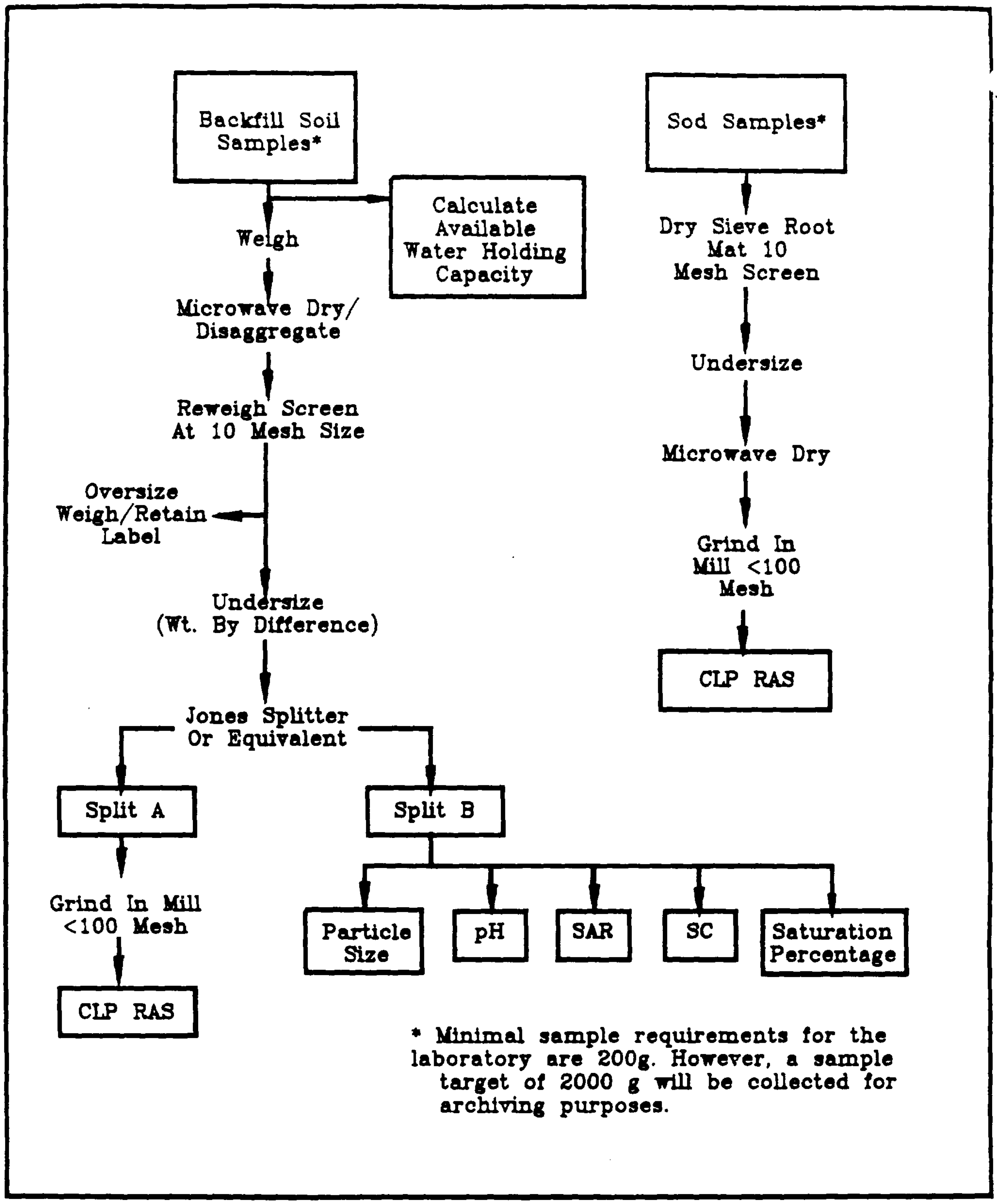

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Figure 2-6.
Backfill Soil And Sod
Preparation And Handling

organic and inorganic particles will be retrieved by dry sieving the sod root mat on a 10 mesh screen. Particles passing the screen will be saved. Approximately 500 grams of sample per potential site will be collected. Each sample will be bagged and properly labelled using the same procedures as other soil samples, and sent to the sample preparation area. Pre-analytical sample preparation procedures are shown in Figure 2-6.

The backfill soil and sod field sample collection matrix is in Table 2-5. This table shows estimates of natural field samples, field QC samples (field duplicates, field blanks, and blind field standards) and analytical requirements. The backfill and sod laboratory program is in Table 2-6. Assuming 4 potential backfill sources and 2 sod sources are sampled, an estimated total of 67 CLP RAS analyses (including quality control samples) will be conducted.

2.4 PRE-REMOVAL SOIL SAMPLE PROGRAM

Once the XRF calibration has been completed, pre-soil removal sampling will be conducted. The primary objectives of pre-removal sampling are to:

- determine if soils are to be excavated from a given property or area;

- establish a priority scheme for soil removal.

Pre-removal sampling will be conducted in residential and commercial yards, and in public areas. Pre-removal sampling will include three steps:

Table 2-5 BACKFILL SOIL AND SOD SAMPLE COLLECTION MATRIX

LOCATION TYPE	PURPOSE	NUMBER OF SAMPLE SITES	NUMBER OF NATURAL SAMPLES PER SITE	TOTAL NUMBER OF NATURAL SAMPLES	SAMPLE INTERVAL (1)	ANALYTICAL PARAMETER LIST	ANALYTICAL METHODS	FIELD DUPLICATES	FIELD BLANKS	BLIND FIELD STANDARDS
Potential Soil Backfill Sources Phase I	Assess Backfill Soil Quality	5	1	5	0-6" 6 to 12" or Bottom	As, Cu, Cd, Pb, Zn and Physical Parameters(2) for all intervals	CLP RAS for metals + Physical Parameters	1	1	—
Potential Soil Backfill Sources Phase II	Assess Backfill Soil Quality	5	2	10	0-6" 6 to 12" or Bottom	As, Cu, Cd, Pb, Zn and Physical Parameters(2) for all intervals	CLP RAS for metals + Physical Parameters	2	2	1
Potential Sod Sources	Assess Sod Soil Quality	2	1	2	Root Zone	As, Cu, Cd, Pb, Zn	CLP RAS	1	1	-
TOTAL		12	4	17				4	4	1

(1) Sample preparation and handling procedures are in Figure 2-6.

(2) Physical parameters are in Table 2-4. Physical parameter measurement procedures are in the Soil Removal SAP.

Table 2-6 BACKFILL SOIL AND SOD LABORATORY ANALYTICAL PROGRAM

SAMPLE SPLIT	PURPOSE	ANALYTICAL PARAMETERS	ANALYTICAL METHODS	NUMBER OF NATURAL SAMPLES	NUMBER OF FIELD QC SAMPLES	LABORATORY DUPLICATES	LABORATORY BLANKS	CONTROL STANDARDS	SPIKES	ICVs	CCVs	ICBs	CCBs	TOTALS
A	Trace Elements Backfill Soils and Sod	As, Cu, Cd, Pb, Zn	CLP RAS	38	7	3	3	3	3	1	4	1	4	67
B	Physical Parameters	Particle Size, Available Water Holding Capacity, pH, SC, SAR	ASTM D422 USDA 60 EPA 9045 USDA 60	36	2 (duplicates)	0	0	0	0	0	0	0	0	38
TOTALS				74	9	3	3	3	3	1	4	1	4	105

1. Preparation of maps which delineate all potentially affected residential yards, commercial properties, schoolyards, playgrounds, parks, streets and alleys.

2. A detailed survey of all property owners and residents in the study area. This survey will include a detailed questionnaire structured to obtain area demographic information.

3. Soil sampling of residential yards, commercial yards, school yards, parks, streets and alleys based on anticipated soil lead concentrations and on survey results.

2.4.1 Map Preparation

Maps will be prepared using recent air photographs of residential East Helena and immediately surounding areas. Detailed air photos with a scale of 1 inch to 50 feet will be prepared delineating houses and yards in East Helena. Prepared maps will include all potentially affected residential yards, commercial properties, schoolyards, playgrounds, parks, streets and alleys. This scale of photographic map will be sufficient to identify features of individual residences including buildings, trees, gardens, lawns, and other features.

2.4.2 Residential Survey and Property Access Agreements

The detailed survey of all property owners and residents in the study area will include a detailed questionnaire stuctured to obtain demographic information on: property owners, current property users or residents, identification of children and their ages, play areas, lot size, and relevant issues of concern for property owners or users. Some of this information has already been obtained as part of the recently completed 1991 child blood lead screening survey conducted by Asarco and the Lewis & Clark County Department of Health. Where possible, information already collected as part of the blood-lead screening survey will be incorporated into the demographic survey. Examples of the survey forms are in Appendix 2. Based on the survey results, property owners and tenants with children will be identified on pre-removal soil sampling maps.

Based on survey results, the sampling priority sequence will be established as described in Section 2.4.3.2. Property access will be obtained from property owners in a general sequence from highest priority to lowest priority. In order to maximize field efficiency, the standard agreement form will include both property access authorization to sample, and authorization to conduct soil removal work. However, as a contingency only, separate agreement forms for property access for sampling, and for soil removal work authorization will be available for properties outside the Yellow zone; allowing property access for soil sampling on properties where authorization for soil removal work is not received. The standard access agreement is included in the Administrative Order (AO), which incorporates this work plan.

2.4.3 Pre-Removal Sampling

The pre-removal soil sampling program will be developed based on the residential area mapping, residential survey information, and anticipated concentrations of surface soil lead. The primary focus of pre-removal sampling, particulary early sampling activities, is on soils outside the yellow zone. Pre-removal sampling has two primary objectives:

1. Identification of locations outside the yellow zone requiring soil removal.

2. Assist in prioritization of soil removal actions.

The Secondary objective is:

1. Definition of areal limits requiring pre-removal sampling.

2.4.3.1 Identification of Soil Removal Locations

Soil excavation and removal will be required in locations where pre-removal sampling and calibrated analysis by XRF indicate soil lead concentrations are 1000 mg/kg or greater. The actual XRF readings that will trigger a removal action will be less than 1000 mg/kg since the removal action trigger is based on a 95% confidence level at 1000 mg/kg. Only samples collected from outside the yellow zone will be analyzed by XRF. All soils within the yellow zone will be excavated.

2.4.3.2 Sampling Priority Sequence

Based on map information, survey results, and anticipated soil lead concentrations, the sampling sequence outside the yellow zone will be categorized in the following decending order:

1. Locations where access is permitted.

2. Residential yards with young children or expectant mothers and daycare centers.

3. Playgrounds, schoolyards, and parks.

4. Other residential yards, gardens and vacant lots.

5. Streets (road apron areas) and alleys.

6. Commercial property yards.

Based on these priority categories, sample sites will be selected with consideration of anticipated soil lead concentrations. Residences with highest (and generally nearest to the yellow zone) lead concentrations will be sampled first.

2.4.3.3 Sampling Strategy

Residential and Commercial Property Yards

A residential yard is considered the smallest unit for remediation. If any composited yard soil sample is determined to exceed 1000 mg/kg lead, the entire property will be scheduled for soil removal. Each average size yard will be divided into 4 to 6 sampling units, with 3 random sampling points within each unit (see Figure 2-7). Samples from the 0 to 1 inch soil interval will be collected from the 3 sampling points and composited. A 200 gram composited sample will be collected to meet minimum laboratory sample requirements. However, where conditions allow, as much as 2,000 grams of composited sample will be collected for archiving. Where possible, sample points will include:

° One sample point where roof drainage drops to the soil;

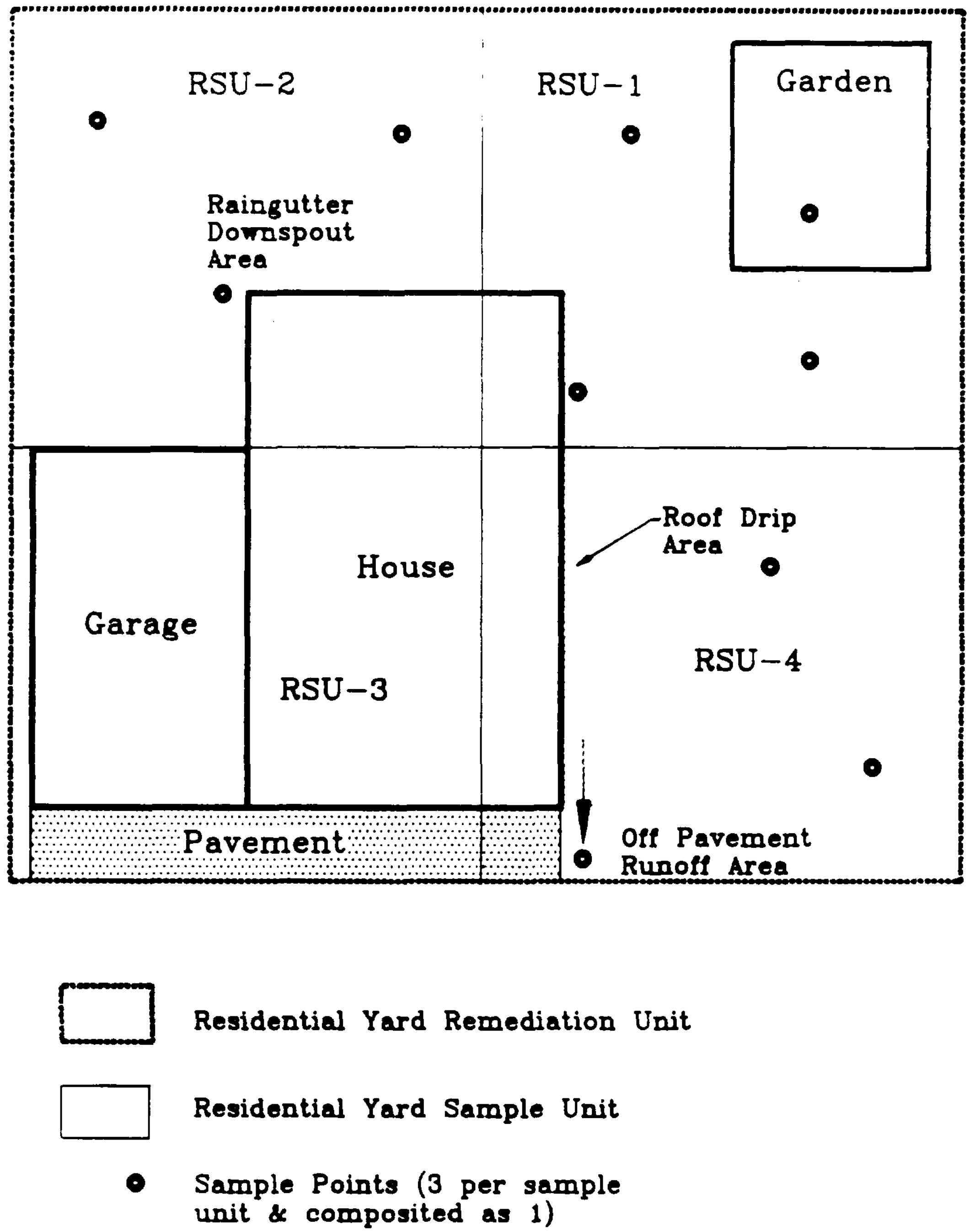

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Figure 2-7.
Typical Soil Sample Collection Points, Pre-Removal & Post-Removal Soil Sampling-Residential & Commercial Yards

- One sample point within two feet of a rain gutter downspout;

- One soil sample point where paved driveway runoff collects in the yard; and

- At least one sample point in vegetable gardens (if present).

If a sample unit is totally covered by a structure (house, garage, paved driveway, etc.), no sample will be collected (see Figure 2-7). This sampling strategy will also apply to small to medium commerical yard areas typical of the East Helena Main Street area.

__Public Area Sampling Strategy__

In general, public areas in East Helena consist of three general types:

1. Playgrounds, schoolyards, parks, and land associated with municipal buildings.

2. Road apron areas between paved surfaces and private property.

3. Unpaved alleys.

Each playground, park or schoolyard, etc. will be divided into 3600 ft^2 sampling units approximately 60 feet by 60 feet, with 3 random sampling points within each unit (see Figure 2-8). Samples from the 0 to 1 inch soil interval will be collected from 3 sampling points and composited. At least 200 grams of composited sample will be collected per sample unit (200 grams

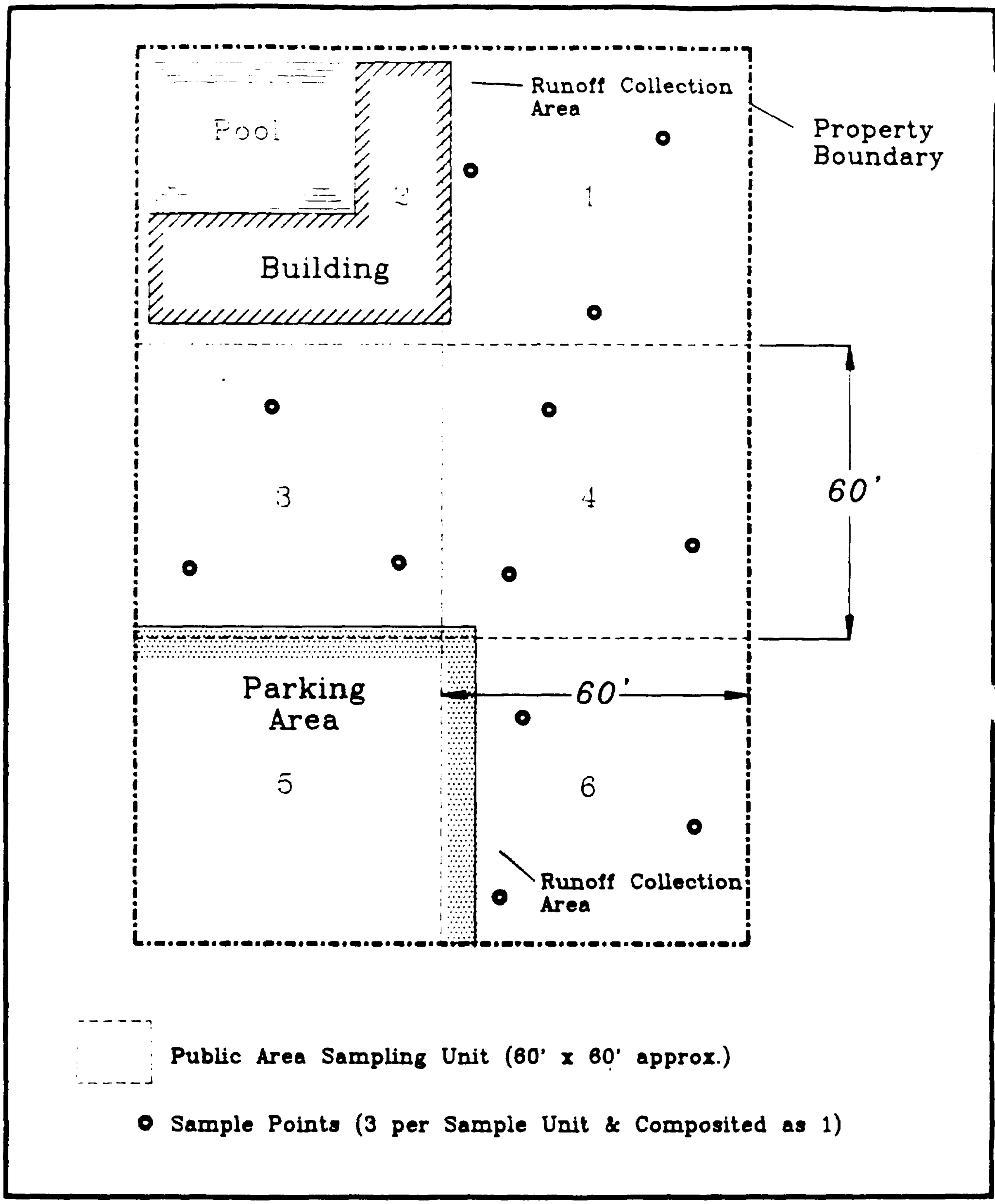

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Figure 2-8.
Typical Soil Sample Collection Points, Pre-Removal And Post-Removal Soil Sample - Playgrounds, Schools, And Parks

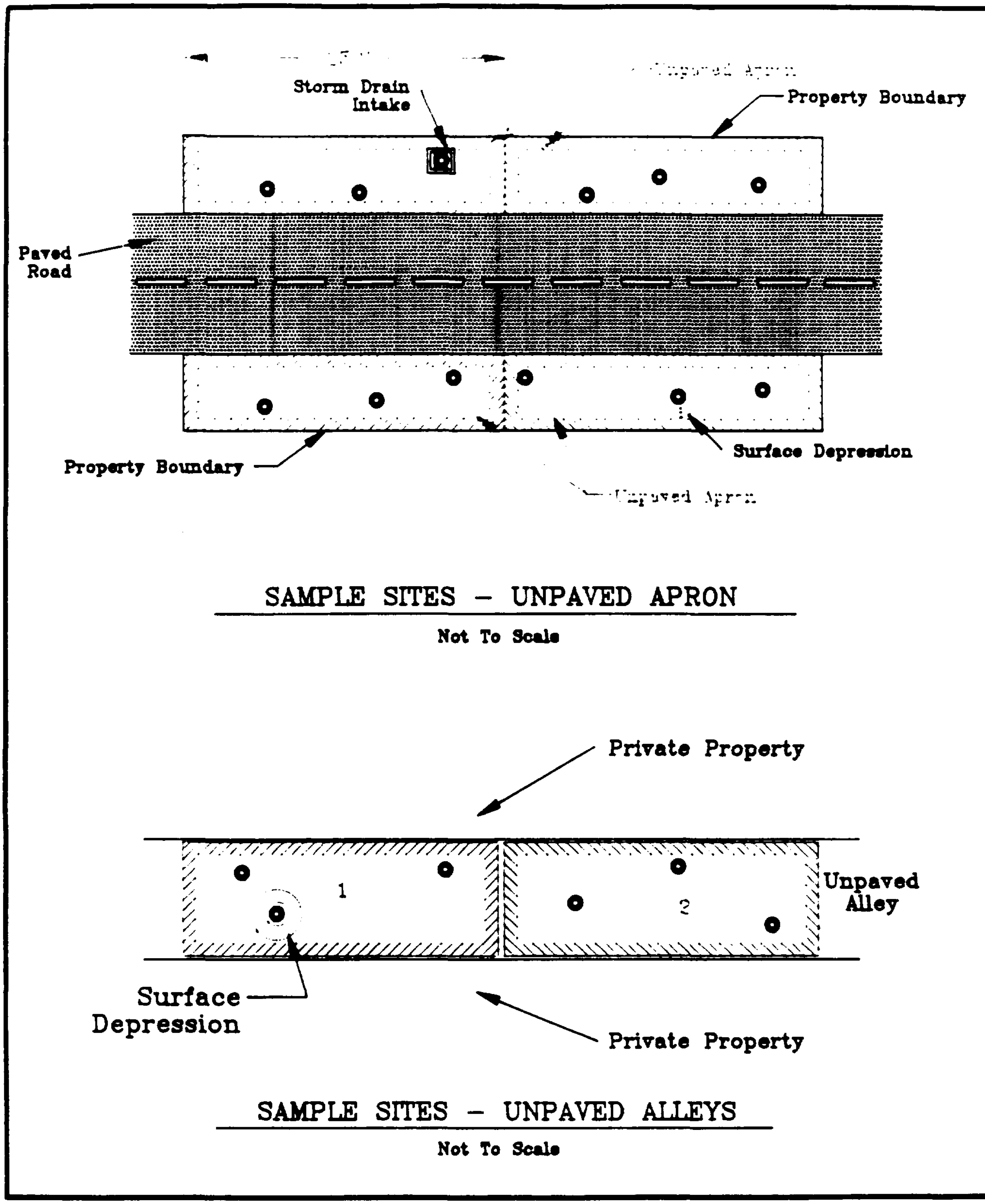
is the minimum sample necessary to meet laboratory requirements, although normal sample volume is expected to range from 1,000 to 2,000 grams). Where possible, sample points will include areas that collect runoff from precipitation. If a sample unit is totally covered by structural features (public buildings, swimming pool, paved parking lot, etc.), no soil samples will be collected.

Unpaved road apron areas will be divided into 150 foot long sample units on both sides of the road (see Figure 2-9), with the width of the sample unit being the distance from the paved surface to the private property boundary. Unpaved alleys will also be divided into 150 foot long sample units with the width bounded by private property (see Figure 2-9). Soil samples from three points in each sample unit will be collected and composited. Where possible, samples will be collected at drainage low spots (storm drain intakes, culvert approaches, surface depressions, etc.).

2.4.3.4 Sample Collection and Preparation Procedures

The pre-removal soil sample collection matrix is Table 2-7. This table shows estimates of natural field samples, field QC samples and analytical requirements associated with pre-removal sampling.

Each of 3 sample points per sample unit will be collected from an area about 36 square inches (6 x 6 inches) or a sufficiently large area to obtain a composite sample of at least 200 grams. Subsamples from the 3 sample points will be composited, and each composite sample (1 from each sample unit) will be bagged, labeled, and sent to the soil preparation and handling area. The sample preparation and handling area will be adjacent to but separate from



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Sample Unit (150 ft. Long)

Sample Points (3 per Sample Unit and to be Composited as 1 Sample)

Figure 2-9. Typical Soil Sample Collection Points, Pre-Removal and Post-Removal Soil Sampling For Unpaved Road Aprons and Alleys

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Table 2-7 PRE-REMOVAL SOIL SAMPLE COLLECTION MATRIX

LOCATION TYPE	PURPOSE	NUMBER OF SAMPLE UNITS	NUMBER OF NATURAL SAMPLES(1)	SAMPLE INTERVAL	ANALYTICAL PARAMETER LIST	ANALYTICAL METHODS	FIELD DUPLICATES	FIELD BLANKS
Sample Program Outside Yellow Zone								
Residential and Commercial Yards	Determine if Soil Pb in Excess of 1000 mg/kg	4-6 per residence	2,184	0-1 inch	As, Cd, Pb	XRF CLP RAS 1/50 XRF HF 1/50 XRF	110	0
Public Areas (Parks and Schools)	Determine if Soil Pb in Excess of 1000 mg/kg	189	189	0-1 inch	As, Cd, Pb	XRF CLP RAS 1/50 XRF HF 1/50 XRF	10	0
Alleys	Determine if Soil Pb in Excess of 1000 mg/kg	158	158	0-1 inch	As, Cd, Pb	XRF CLP RAS 1/50 XRF HF 1/50 XRF	8	0
Road Aprons	Determine if Soil Pb in Excess of 1000 mg/kg	590	590	0-1 inch	As, Cd, Pb	XRF CLP RAS 1/50 XRF HF 1/50 XRF	30	0
TOTAL			3,121				128	0

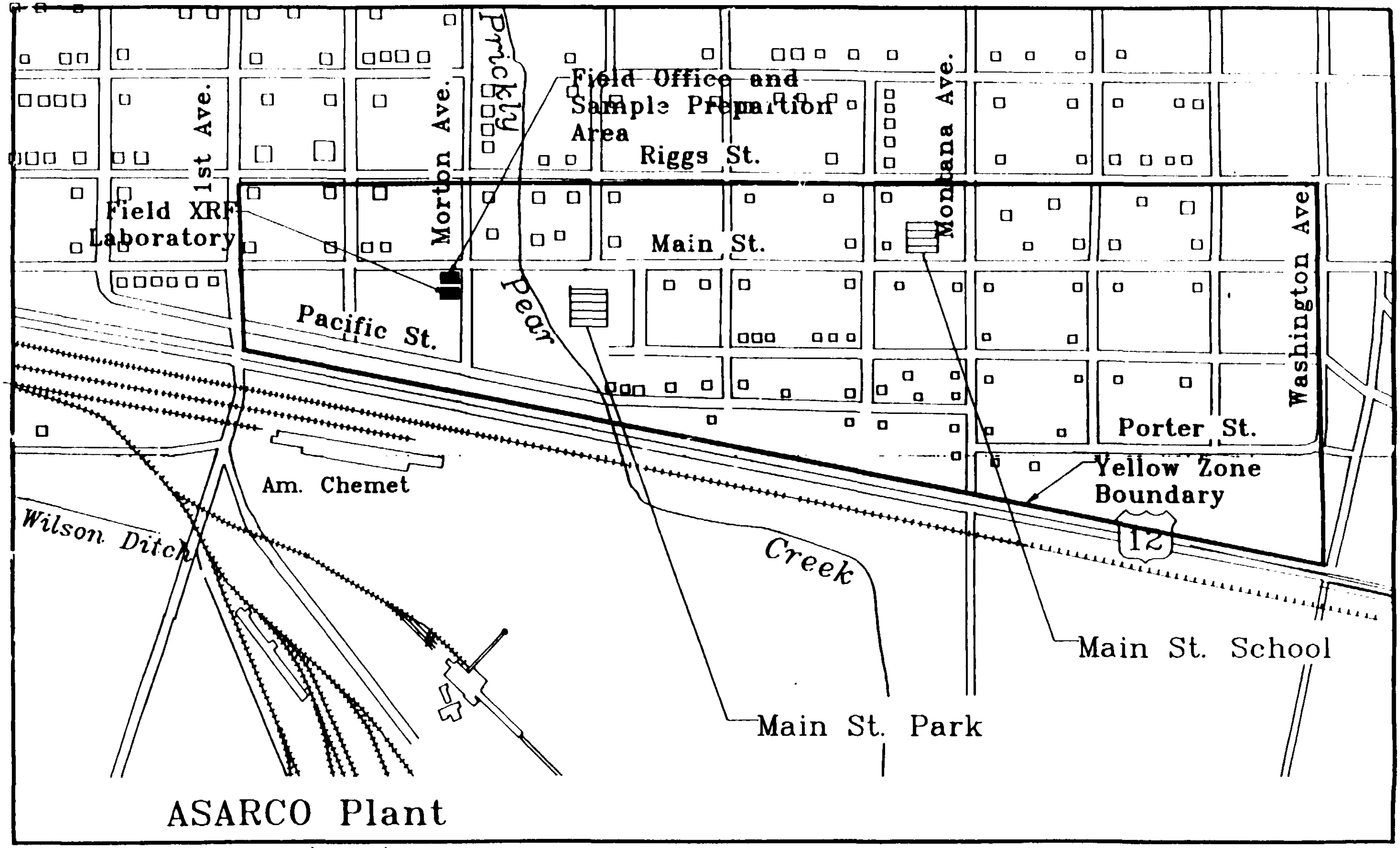
(1) Based on an assumed 4 sample units per residence and an estimated 546 residences outside of the yellow zone.

the field XRF laboratory trailer, which will be located just south of Main Street in East Helena (see Figure 2-10). These facilities will remain separate to minimize the potential for environmental interferences to XRF analyses. The pre-analysis sample preparation diagram for pre-removal samples is in Figure 2-11. Pre-removal samples will be disaggregated, screened, split, and ground in a mill using the same general procedures established for the initial sampling campaign. Pre-removal samples will be split into 2 subsets (A and B, see Figure 2-11). Split A will be analyzed by XRF and split B will be archived. Once split A has been analyzed it too will be archived or used for quality assurance analysis. A frequency of 1 in 50 samples will be analyzed by wet chemistry methods to confirm XRF analyses (see Table 2-7).

The pre-removal sampling analytical program is summarized in Table 2-8. An estimated 2,750 samples including quality control samples, will be analyzed by the XRF technique.

2.4.3.5 <u>Pre-Removal Sampling Limit</u>

Pre-removal soil sampling outside the yellow zone will be conducted on a priority basis as described in Section 2.4.3.2. In general, sampling will begin nearest the yellow zone and progress outward from the yellow zone. As more distant areas are sampled, lower concentrations of soil lead are expected. Ultimately, an outer boundary, beyond which pre-removal sampling will not be required, will be established. Based on pre-removal sample data, an outer sampling boundary will be established where the soil sample population can be statistically predicted to have an average lead concentration less than 1000 mg/kg at the upper 95% confidence interval.



Scale: 1" = 500 feet (Approx.)

NORTH

Figure 2-10. Location of XRF Field Laboratory and Pre-Analytical Sample Preparation Area

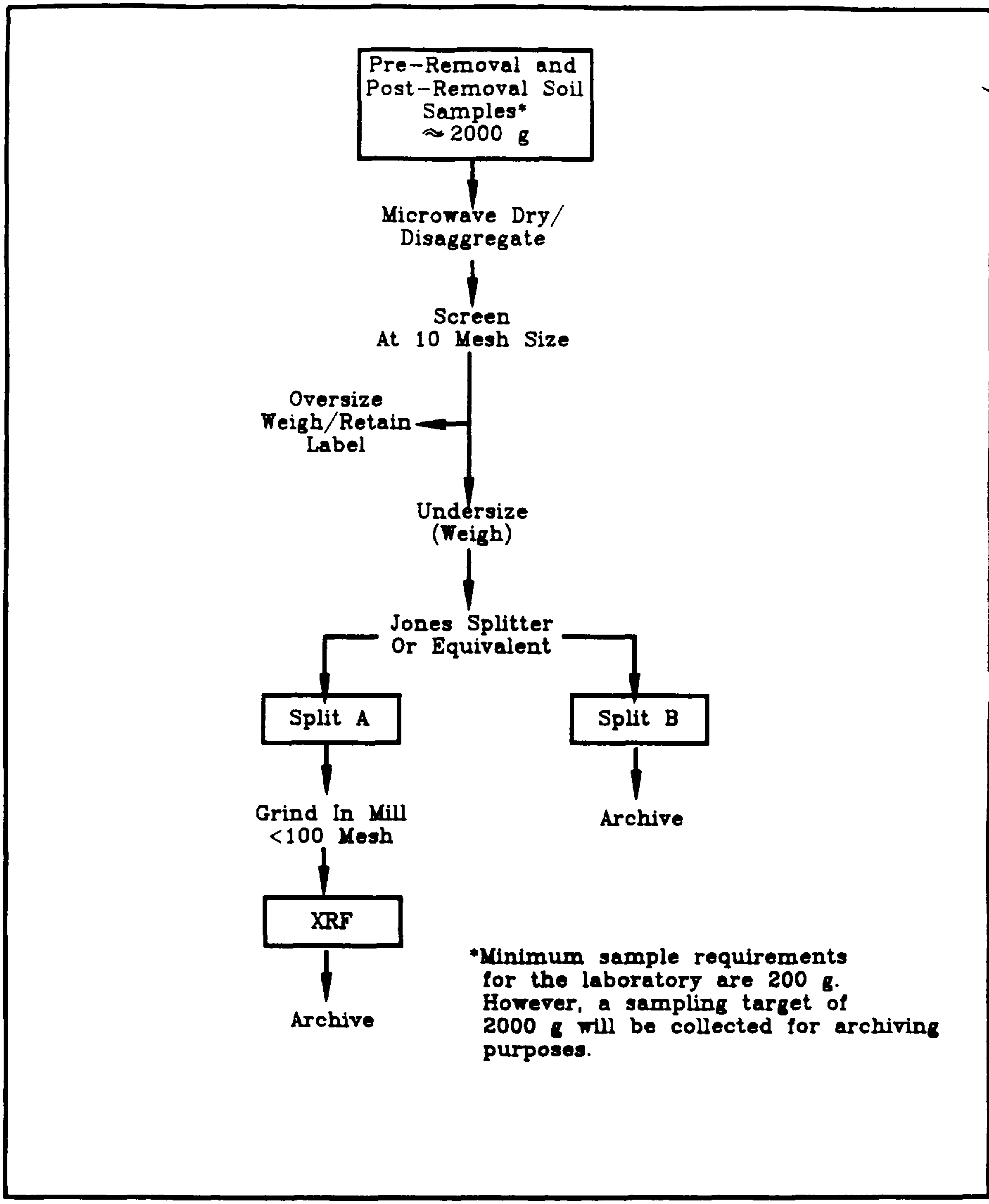


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Figure 2-11.
Pre-Removal & Post-Removal Soil Sample Preparation & Handling

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Table 2-8 PRE-REMOVAL SOIL SAMPLE ANALYTICAL PROGRAM (Outside Yellow Zone)

SAMPLE SPLIT	PURPOSE	ANALYTICAL PARAMETERS	ANALYTICAL METHODS	NUMBER OF NATURAL SAMPLES	NUMBER OF FIELD QC SAMPLES	LABORATORY DUPLICATES	LABORATORY BLANK	CONTROL STANDARDS	SPIKES	ICVs *	CCVs	ICBs	CCBs	TOTALS
A	Determine if Soil Removal is Required Outside Yellow Zone	As, Cd, Pb,	XRF	2,184	110	115	0	115	0	24	80	0	0	2,628
			CLP RAS	44	--	3	3	3	3	3	5	3	5	72
			HF	44	--	3	3	3	3	3	5	3	5	72
B	Archive	None	None											
TOTALS				2,272	110	121		121	6	30	90	6	10	2,772

As sample collection progresses outward, an on-going analysis of XRF results will be conducted. The East Helena sampling area will be divided into evaluation sectors as shown in Figure 2-12. These sectors are separated by rays, 20 degrees apart. Pre-removal samples will be statistically evaluated on a sector by sector basis. Outward advancing sampling efforts will be terminated where a combination of outer sample analyses statistically predict a soil (population) mean below 1000 mg/kg at the upper 95% confidence limit. The U95 boundary will be conservatively set at the soil sample location in a given sector which is farthest from the yellow zone. Figure 2-13 illustrates an example of the boundary selection process.

The 1983 child lead study and RI data show that, although soil lead concentrations generally decrease with distance from the smelter, some anomalies do occur. To compensate for potential anomalies, sample data used for boundary selection of an evaluation sector will be larger than the minimum number required to be statistically significant. Based on site-specific knowledge and professional judgement, approximately 6 to 20 samples will be used to establish an outer sampling boundary for an evaluation sector.

2.5 POST-REMOVAL SOIL SAMPLE PROGRAM

After soil excavation to the standard removal depth (determined by initial soil sample program, see Section 2.2), but prior to backfilling, soils that remain after excavation is completed will be sampled and analyzed using the XRF technique. The objective of post-removal soil sampling is to document soil metal concentrations that remain after removal has been conducted and to determine whether the soil removal meets acceptable cleanup levels.

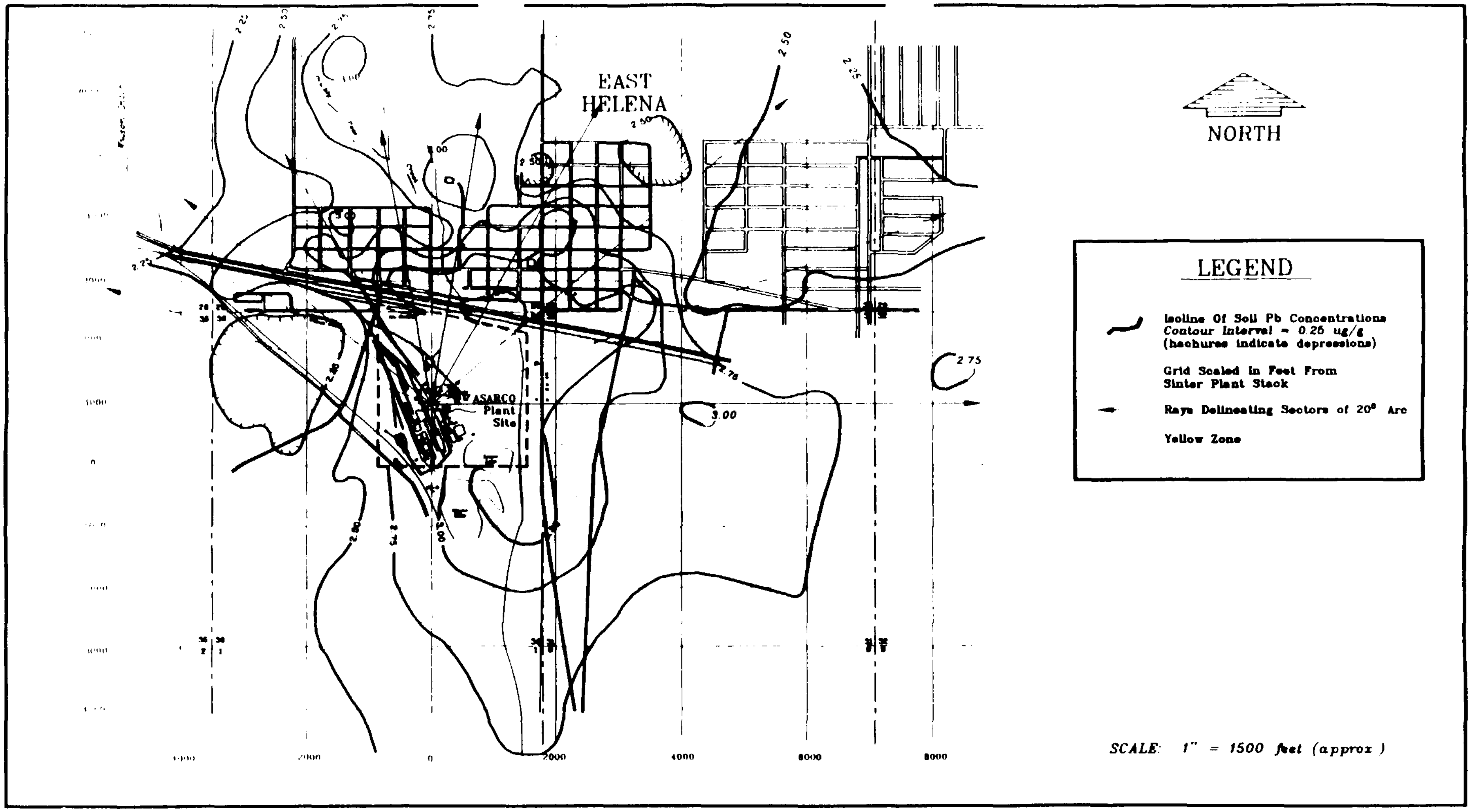

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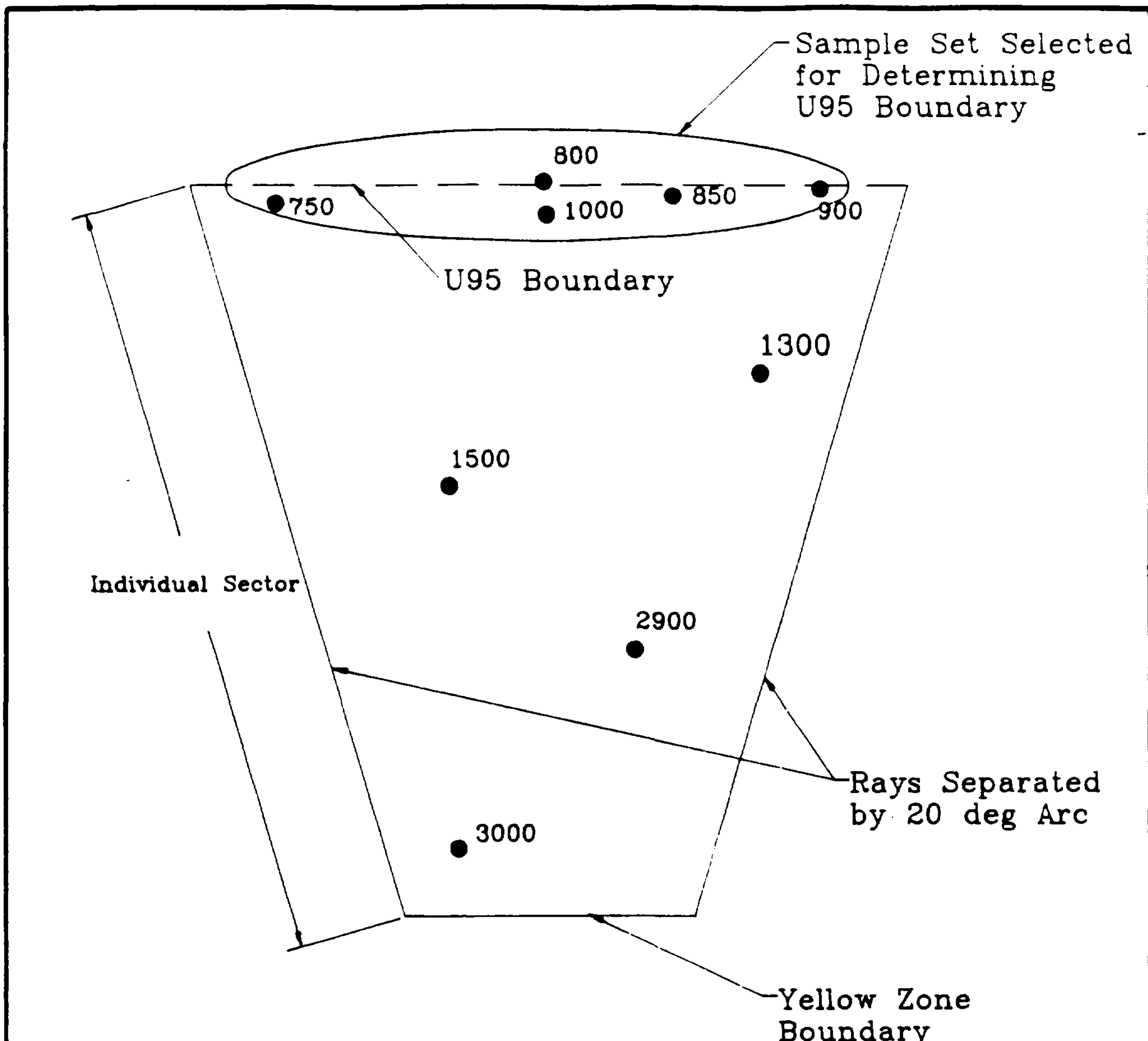
Figure 2-12.
Pre-Removal Soil Sample
Boundary Evaluation Sectors



$\sigma = \sqrt{\frac{n}{n-1}} \times \bar{S}$ The Student's t-Distribution (small sampling methods) will be used to determine areas under the curve corresponding to the degrees of freedom (df).

Number of samples	$n = 5$
Degrees of freedom	$df = n-1$
Sample mean	$\bar{x} = 860$
Std. dev.of samples	$\bar{S} = 86$
Std. dev. of population	$\sigma = 96$
Std. dev. of sample means	$\sigma_{\bar{x}} = 43$
	$(\sigma_{\bar{x}})(A) = U95 - \bar{x}$
	$(43)(2.776) = U95 - 860$
Upper 95% confidence limit	$U95 = 979$ ppm Pb

Based on the preceding statistical analysis, the U95 boundary would be drawn at the location of the most distal samples used in the analysis.

Legend

● Soil Pb Concentration

Not To Scale

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Figure 2-13. Pre-Removal Soil Sample Outer Boundary Selection Process

Soil concentrations of 440 mg/kg lead and 100 mg/kg arsenic will be used as the final cleanup criteria. However, a minimum of 8 inches of soil will be removed in all areas, except gardens, and the expected concentrations of lead and arsenic remaining (based on depth-integrated soil samples taken during remedial investigations) are well below the final cleanup criteria mentioned above. For example, of approximately 60 depth-integrated samples taken by EPA (Phase 1 RI), lead concentrations in the 8-15 inch soil profile ranged from a low of 5 mg/kg to a high of 113 mg/kg and arsenic concentrations in the 8-15 inch profile ranged from below detection levels to a high of 60 mg/kg.

Residential yards, commercial yards, and public areas will be resampled using the same procedures and protocol as for pre-removal sampling (Section 2.4). All post-removal soil sample units both inside and outside the yellow zone will be sampled from the 0 to 1 inch depth, after excavation, and analyzed by XRF. If remaining soil lead concentrations in a sample unit exceed the lower 95% confidence limit of the 440 mg/kg lead cleanup level or 100 mg/kg cleanup level, the following actions will be implemented.

1. Additional soil samples will be collected to determine the depth of soils with elevated lead concentrations. Using hand tools or available on-site excavation equipment, soil samples will be collected using procedures described in Section 2.2.

2. Once the depth of soils with elevated metals has been determined, additional soil will be removed until:

a) the remaining soil concentrations are below the 95% confidence limit of the 440 mg/kg lead cleanup level and 100 mg/kg arsenic cleanup level, and/or

b) a sufficient depth of soil has been excavated to eliminate surface soils as a potential exposure pathway. Remaining soils will be compared against cleanup levels of 440 mg/kg lead and 100 mg/kg arsenic to assess if removal meets final cleanup criteria.

Based on the results of post-removal soil sampling, Asarco's on-site remedial manager supervising the removal action will determine the proper course of action. The criteria and decision process for determining the extent of soil removal is discussed in detail in Section 3.0 (Soil Excavation and Removal Procedures, Protocol and/Logistics).

3.0 SOIL EXCAVATION AND REMOVAL PROCEDURES, PROTOCOL AND LOGISTICS

Figure 3-1 outlines the general sequence of events that will be conducted as part of the soil removal action. Some impacts are anticipated for the people of East Helena including disturbances at individual homes, businesses, churches, schools, town services (police, fire department, utilities and government). Soil removal will be implemented to minimize to the extent practical potential impacts to the residents of East Helena.

3.1 INITIAL SURVEY AND QUESTIONNAIRE

As described in Section 2.4.2, a detailed survey will be conducted of all property owners and residents in the study area. This survey will not only include information collected as part of preliminary and pre-removal sampling efforts outside the yellow zone, but will also include residences and properties inside the yellow zone which are not covered during these early sampling efforts. Demographic information to be obtained after receiving soil removal access agreements includes: property owners, current property users or residents, play areas, lot sizes, vegetable gardens, flower gardens, grass coverage, and relevant issues of concern of the property owners or users. The known history of each property, including importation of new soil, grading, tilling, floods or other disturbances also will be obtained. Survey information will be used to plan the removal process, and allow owners, residents or property users some input to the removal process. Relevant portions of the survey information will be added to air photo maps (see Section 2.4.1) to aid in the planning process. Examples of the survey form are in Appendix 2.

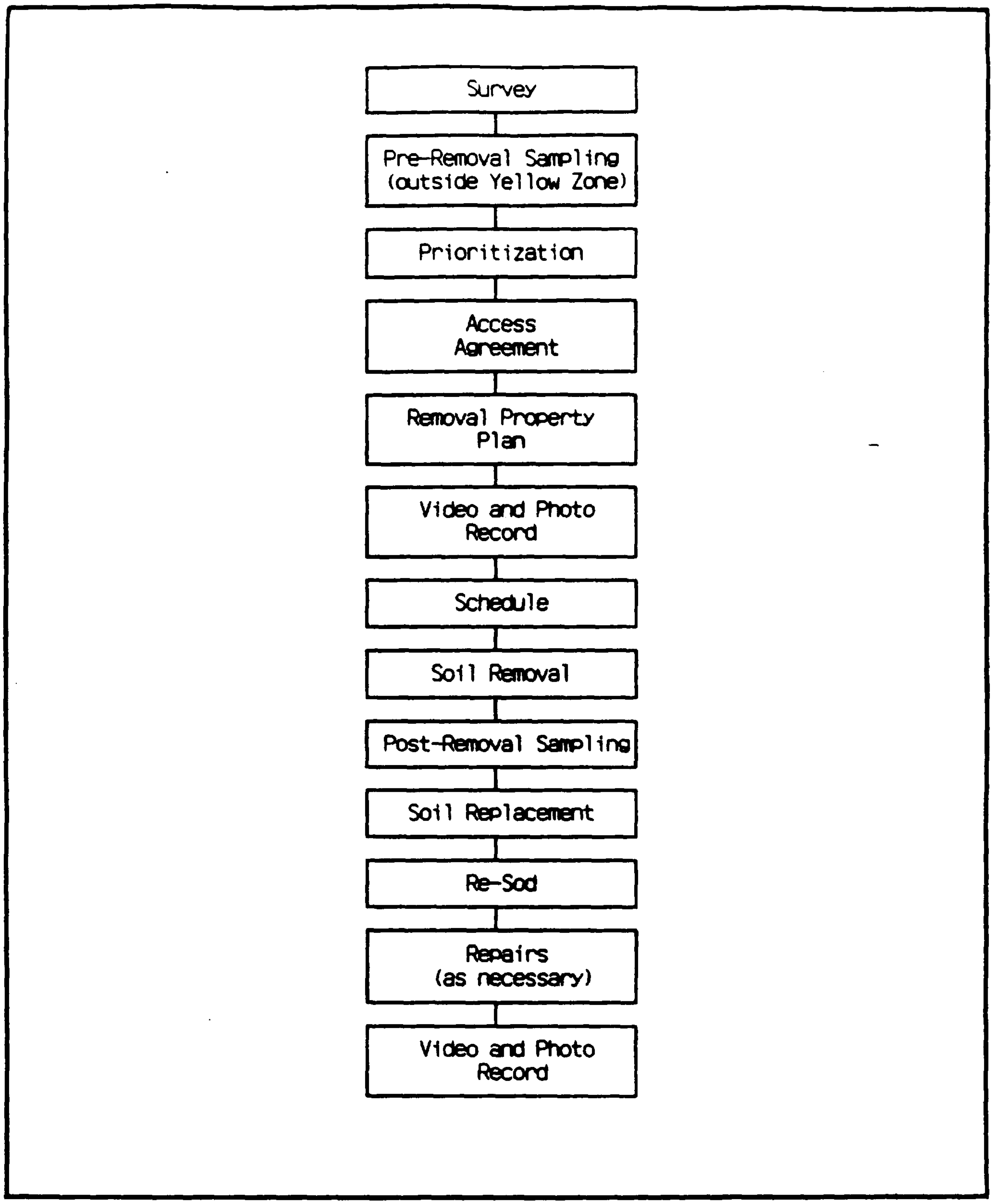


Figure 3-1

Soil Removal Procedure Schematic

3.2 REMOVAL PRIORITY SEQUENCE

Based on survey results and anticipated or measured soil sample concentrations, the soil removal sequence will be the same descending priority used for obtaining pre-removal samples outside the yellow zone:

1. Locations where access is permitted and consent to proceed has been obtained (see Section 3.3);

2. Residential yards with young children or expectant mothers and daycare centers;

3. Playgrounds, schoolyards, and parks;

4. Other residential yards, gardens and vacant lots;

5. Streets (road apron areas) and alleys;

6. Commercial property yards.

This prioritization will be applied equally to both the yellow zone and areas outside the yellow zone. It is anticipated that most of the early removal action will be conducted in the yellow zone. Based on survey results and soil metal concentration data, residences, public and other areas will be ranked in descending priority to help schedule the soil removal actions.

3.3 PROPERTY OWNER NOTIFICATION, ACCESS AGREEMENTS, AND PRE-REMOVAL DOCUMENTATION

Once property or public area has been identified for removal action, the resident users and/or property owners will be contacted for an on-site meeting to discuss the removal action. Prior to initiation of any removal action, an access agreement must be signed by the property owner. The agreement will detail the responsibilities of the removal team and of the property owner. An example of an authorization agreement is included in the project Administrative Order, to which this work plan will be attached.

Removal team responsibilities include:

- consultation of property owner to reach a consensus on removal time schedules and the scope of work of the removal action,

- removal and replacement of soils with metal concentrations above the 1000 mg/kg lead action level,

- removal and replacement of sod and other vegetation,

- restoration of the property to pre-removal conditions.

Owner/tenant responsibilities include:

- removal of obstructions including boats, trailers, vehicles, swing sets, wood piles, dog houses, etc.

- removal of materials and objects stored in garages and sheds with dirt floors,

- removal of flower bulbs or plants an occupant may wish to save (does not include garden vegetables), and

- watering and maintenance of replacement sod.

Once authorization is obtained, individual property design plans will be prepared to document pre-removal site conditions and plan the soil removal activities. The plans will delineate garden areas, flower beds, yard parking areas for boats and trailers, and other landscape features such as fences, walkways, sidewalks, and driveways. Utilities including natural gas, water supply, sewer, electrical power, cable television, and others will be located and mapped on the design plan. If present, underground lawn sprinklers will also be located and mapped to the extent practicable.

Video recordings and 35 mm photographs documenting initial site conditions will be obtained. Video recordings will include distance and close-up shots of the house, garages, siding conditions, yard, fences, sidewalks and driveways. Design plans, and photo/video records will be maintained.

3.4 REMOVAL PROCEDURES FOR RESIDENTIAL YARDS

Once access agreements have been signed, and site pre-removal conditions have been documented, a schedule for soil removal will be developed in consultation with the property owners and tenants. Soil removal will consist of a series of activities.

1. Soil and sod will be removed using a variety of powered equipment and hand tools, as necessary. Primary equipment will consist of bobcats,

front-end loaders and small backhoes. A minimum of 8 inches of soil will be removed. Preliminary sampling results (see Section 2.2) will be used as a guide to confirm the minimum 8 inch standard removal depth. Post-removal sampling (see section 2.5) will be conducted to confirm soils above the 1000 mg/kg action level have been removed and document remaining soil lead concentrations.

2. Excavated soil will be transported to the soil stockpile area located in the east fields, east of the Asarco plant. Soil stockpiling procedures are discussed in detail in Section 4.0.

3. Backfill soil will be imported and the property returned to its original grade. Minor alterations (such as grade/drainage improvements) may be implemented if agreement is reached by both the property owner and Asarco.

4. Sod and small landscape features (bushes, small trees, decorative plants) will be salvaged and/or replaced.

5. Repairs will be implemented as necessary. Anticipated work includes replacement of damaged walks and drives, house siding, and underground sprinkler system repair.

3.4.1 Soil Removal Protocol

Although preliminary sampling (see Section 2.2) will be used to help assess a standard removal depth, based on the limited soil depth data available, it is has been agreed that 8 inches of soil will generally result in remaining soil metal concentrations below cleanup level. Following soil removal, excavated areas will be sampled and analyzed by XRF to document remaining soil lead concentrations using the procedure described in Section 2.5. If remaining soil lead concentrations in a given sample unit exceed the lower 95% confidence limit of 440 mg/kg, additional soil samples will be collected to determine the depth of soil with elevated lead concentrations above cleanup level. Once the depth of soil with elevated lead concentra-tions has been determined, additional soil will be removed until:

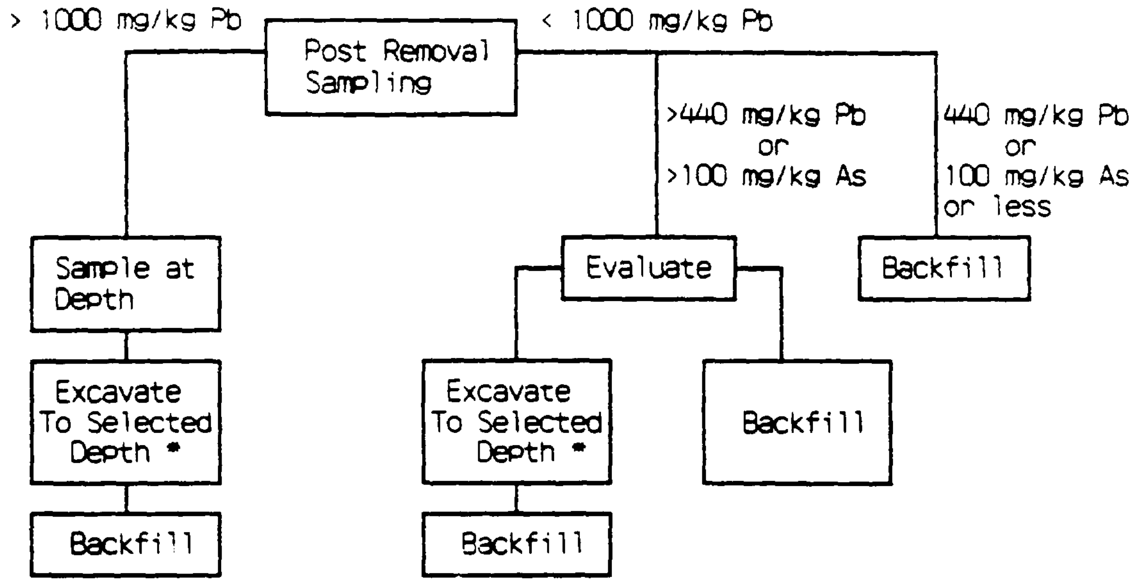
a) the remaining soil concentrations are below the 95% confidence limit of the 440 mg/kg cleanup limit, and

b) a sufficient depth of soil has been excavated to eliminate surface soil as a potential pathway. Soil removal depths will be no less than 8 inches with a maximum depth of removal of 12 inches. Remaining soils will be compared against soil cleanup goals of 440 mg/kg lead and 100 mg/kg arsenic to determine if removal meets final cleanup criteria.

Based on results of post-removal soil sampling, the removal action will take place in accordance with the procedures outlined in Figure 3-2. A general decision flow chart is shown on Figure 3-2.

3.4.2 Removal Schedule

Soil excavation work will be scheduled to minimize disturbance to the property owner or tenant and to minimize impacts to the community. Removal activities will be conducted with standard construction work hour timeframes (generally 7:30 AM to 4:30 PM). Property owners and tenants will be notified



* Selected depth will be based on area use. Maximum excavation depth for sodded areas will be 12 inches. Maximum excavation depth in unsodded park areas where disturbances can occur (under swing sets, carousels, jungle gym etc.) will be 18 inches. Maximum excavation depth for road aprons and alley areas will be 8 inches. Lime may be applied if remaining soil is in excess of 1000 mg/kg prior to backfill.

Figure 3-3. Soil Excavation Decision Flowchart-Public Areas of anticipated times and dates, and work will be conducted in accordance to the schedule to the extent practicable.

3.4.3 Utilities

All known utilities will be located and marked on site prior to removal activities. Excavation will be conducted in a manner to minimize potential impacts to marked utilities. Most underground utilities are buried deeper than the agreed upon soil removal depth (8 inches) and should not be disturbed. However, cable television lines are often buried at shallow depths and damage to these lines is more probable. Where interruptions to any services occur as a result of removal activities, utility companies will be contacted as soon as possible to aid in rapid re-establishment of services.

3.4.4 Landscape Features

Trees and shrubs that are removed during soil excavation will be replaced at the owners' option. Trees and shrubs that die (within 1 year) as a result of the soil excavation will also be replaced. Soil will be hand dug from around the roots to minimize stress to the tree. Exposed tree roots will be covered with backfill soil as soon as possible. Tree roots that must be left exposed overnight will be covered with wet burlap to reduce desiccation. Walkways, sidewalks and driveways will not be removed. Any damage to these structures will be repaired as necessary. Fences or other decorative or aesthetic structures will not be disturbed after soils and sod have been replaced.

3.4.5 Vegetable Gardens

Since tilling and seasonal turnover typically occurs in garden areas, the soil removal protocol for vegetable gardens is slightly modified from the overall plan of a standard 8 inches soil removal depth. Based on site conditions and professional judgement of the Asarco site remedial manager, one of the following procedures will be implemented for garden soils:

1. Soil removal to a maximum depth of at least 2 feet.

2. Collection of pre-removal samples to a depth of 2 feet to assess removal requirements. A 200 mg/kg soil lead concentration and a 100 mg/kg arsenic concentration remaining after soil removal will be used as guideline measures to assess if removal has met final cleanup criteria.

3.4.6 Underground Sprinkler Systems

Where underground lawn sprinkler systems have been installed, major components of the system (heads, valves) will be salvaged to the extent possible. The system will be replaced to its original condition after soil removal has been completed.

3.4.7 Special Instructions

In some circumstances, property owners may (at their own expense) elect to implement improvements or changes to their property during the removal process. Potential improvements by the owner may include installation of new sprinkler systems, pouring concrete or other construction activities best conducted after soil removal and before soil replacement. Efforts to accommodate property owner activities will be made where possible. Details will be negotiated as necessary between the Asarco on-site remedial manager and the property owner. Property restoration will be designed to accommodate the owner to the extent reasonably possible. This may include selection of areas for soil backfilling and sodding, and gravel areas for parking.

3.5 REMOVAL PROCEDURES FOR PUBLIC AREAS

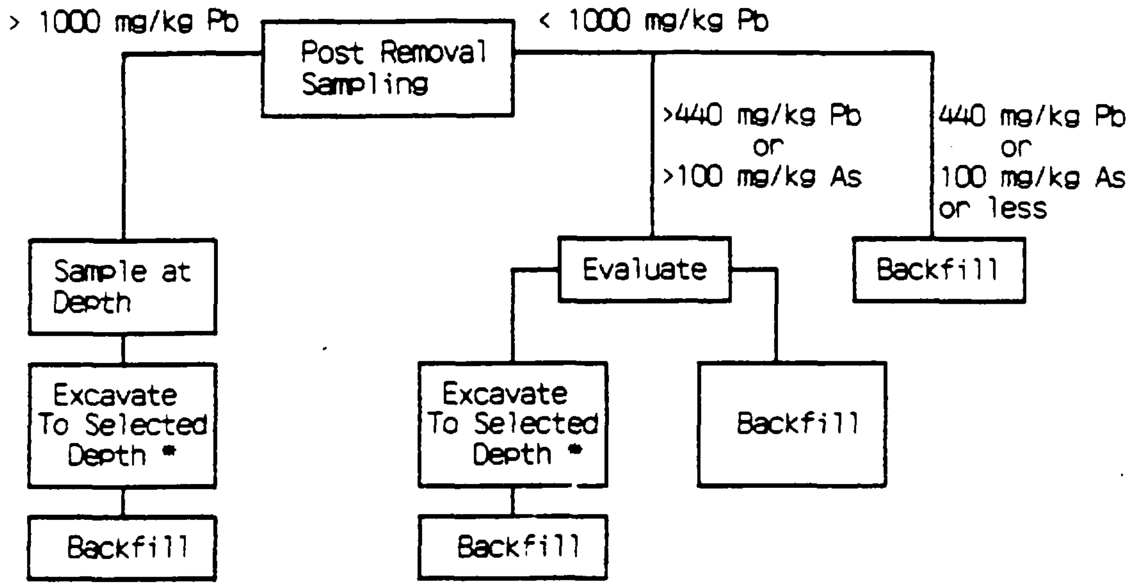
Soil removal procedures for public areas are essentially the same as those for residential soils. Once access agreements have been signed and site pre-removal conditions are documented, a schedule for soil removal will be developed in consultation with the appropriate public officials.

3.5.1 Public Area Soil Removal Protocol

The soil removal protocol for public areas is essentially the same as for residential soils. Soils will be removed to a standard removal depth of 8 inches. Remaining soils will be resampled and analyzed by XRF using procedures described in Section 2.5. If remaining soils exceed the 95% confidence limit of 1000 mg/kg lead, additional soil samples will be collected. Once the depth of soils with lead concentrations has been assessed, additional soil will be removed. If remaining soils are below 1000 mg/kg lead but above 440 mg/kg lead or 100 mg/kg arsenic, the appropriate course of action will be determined based upon the decision flow chart in Figure 3-3. A factor in the decision process will be the use of the arearemediated. A general decision flow chart for soil removal in public areas is in Figure 3-3.

3.5.2 Removal Schedule

Public area soil excavation activities will be scheduled to minimize community impacts. Removal activities associated with school areas will be conducted where possible during summer months when school ground use is mini-



* Selected depth will be based on area use. Maximum excavation depth for sodded areas will be 12 inches. Maximum excavation depth for garden areas will be 24 inches. Lime may be applied if remaining soil is in excess of 440 mg/kg prior to backfill.

Figure 3-2. Soil Excavation Decision Flowchart-Residential Yards mal. Work conducted on road aprons and alleyways will be scheduled to the extent practical to minimize conflict with road traffic. Standard construction hours will be 7:30 AM to 4:30 PM. Public and school officials will be notified of anticipated times and dates, and work will be conducted in accordance with the schedule to the extent it is practicable.

3.5.3 Utilities

All known utilities will be located and marked on site prior to removal activities. Excavation will be conducted in a manner to minimize potential impacts to marked utilities. Most underground utilities are buried deeper than the anticipated soil removal depth (8 inches) and should not be disturbed. However, cable television lines are often buried at shallow depths and damage to these lines is more probable. Where interruptions to any services occur as a result of removal activities, utility companies will be contacted as soon as possible to aid in rapid re-establishment of services.

3.5.4 Landscape Features

The procedures for handling trees, shrubs, fences, walkways and other structural features will be essentially the same as for residential yards (see Section 3.4.4).

3.6 MINIMIZATION OF SHORT-TERM IMPACTS

Soil removal in residential yards and public areas will result in unavoidable short term impacts to the community. Expected impacts include fugitive dust at removal sites, soil spills during transport, traffic from large equipment and haul trucks, increased noise, and potential security problems for displaced owners' belongings and work equipment. All work will be conducted in a manner to minimize potential impacts.

3.6.1 Fugitive Dust Control

Dust suppression mist sprays will be used to minimize the potential for fugitive dust. Application rates will be regulated to control dust during excavation, yet not result in development of mud. The objective is to minimize airborne dust and, at the same time, minimize production of mud which could be transported off-site by haul trucks and other equipment. Dust suppression equipment will consist of standard garden hoses and spray regulators. Outdoor faucets and hydrants from private residences and public areas will be used as water supply sources. In locations where water sources are not available, such as road aprons and some alleys, a tanker truck or trailer will provide the water supply.

3.6.2 Air Quality Monitoring

Ambient air quality in East Helena will be monitored for ambient lead concentrations using the existing Hadfield, Firehall, Dartman, and Old Railroad stations, and an additional station located near the east end of the yellow zone (see Figure 3-4). All stations are or will be equipped with High Volume (Hi-Vol) air samplers and will be calibrated and operated in accordance with the project air quality QAPP (Hydrometrics, 1989).

Site specific air quality will also be monitored during construction activities. Air samplers will be worn by on-site workers to monitor potential worst case ambient air quality conditions. A personal air sampler will also be worn by one person of the removal team to monitor air quality

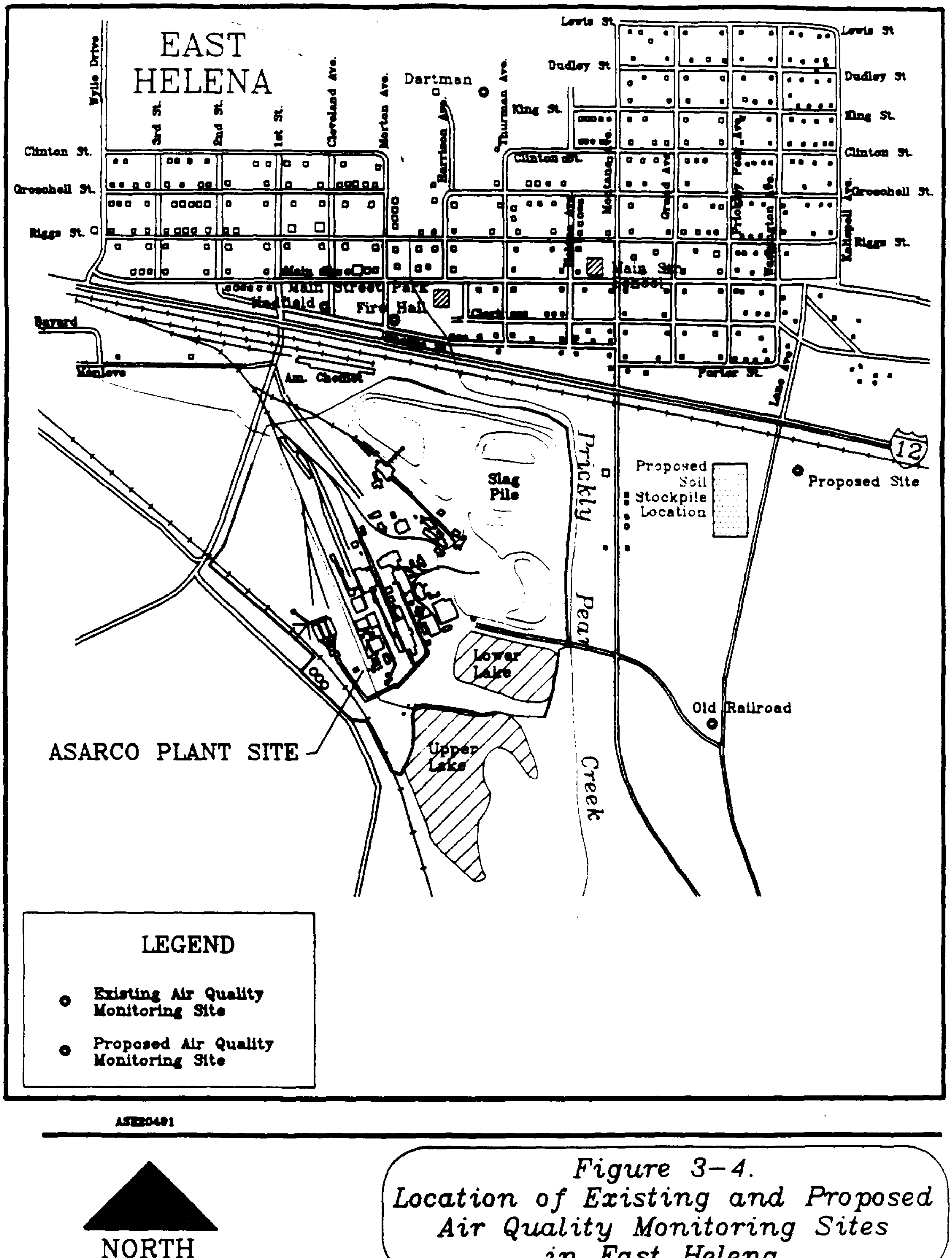


Figure 3-4.
Location of Existing and Proposed Air Quality Monitoring Sites in East Helena

conditions inside excavation equipment cabs and to provide data on the breathing zone of remedial team workers. If site specific monitoring suggests ambient air lead concentrations are excessively higher than typically measured in the East Helena area, or are higher than worker Permissible Exposure Limit (PEL) for lead (50 ug/m^3), a reevaluation of dust suppression methods in use at excavation sites will be conducted.

3.6.3 Spillage Control

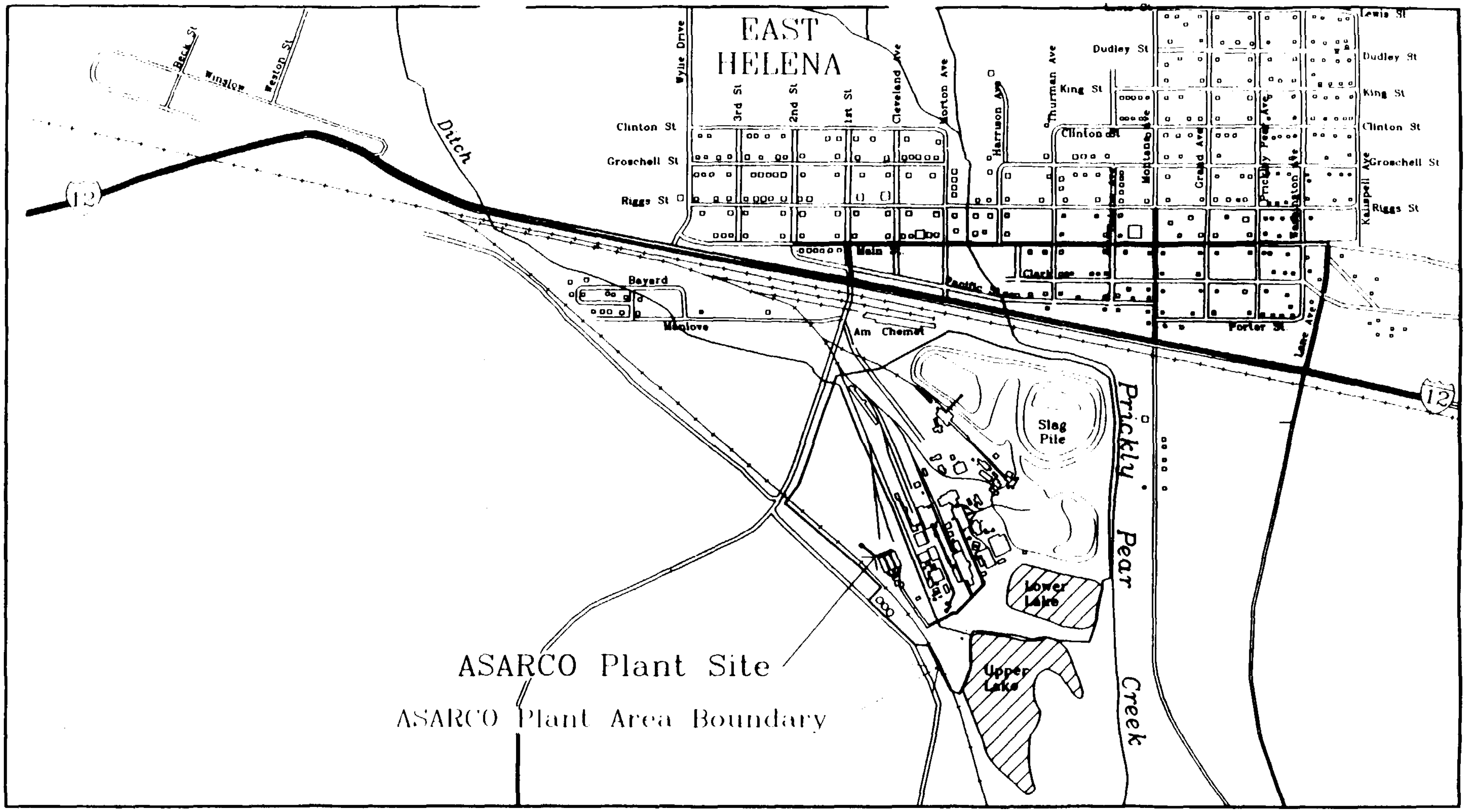
In order to minimize the potential for spillage during soil transport, haul trucks containing excavated soils will be covered by a tarp. In addition, work activities will not be conducted during excessive precipitation periods in order to reduce potential transport of mud off-site by haul trucks and other working vehicles.

3.6.4 Traffic Control

Considerable transport of soil, sod and other materials will occur during the soil removal process. In order to minimize the disturbance to the East Helena community, haul truck traffic will be directed along the major roads and highways to the extent possible. In order to minimize disturbances in residential areas, traffic into and out of East Helena will be directed from Highway 12 along major city streets using the most direct routes available. Primary traffic routes for the soil remediation project are shown on Figure 3-5.

3.6.5 Noise Reduction

As described in Section 3.4.2, construction activities will be conducted during standard construction work hours between 7:30 AM to 4:30 PM; thus,



NORTH

Legend

Yellow Zone Area

Primary Traffic Route

Scale: 1" = 800 feet

Figure 3-5 Primary Traffic Route for Soil Removal Project limiting noise impacts to daytime hours. All large power equipment used, including haul trucks, backhoes, front-end loaders, bobcats, and air compressors will be properly equipped with mufflers to limit construction noise.

3.6.6 Equipment Security

Following completion of daily activities, smaller implements such as hand tools, water hoses, and other portable equipment will be transported or stored in a secure location. Large equipment will either be transported off site to a secure area, or safely secured and locked to prevent vandalism, or potential injury. A security area northwest of the Asarco plant will be used to store equipment away from the soil removal site. The area is equipped with a chainlink fence and can be locked to prohibit access. Equipment security procedures are addressed further in the site Health and Safety Plan (see Appendix 4).

3.6.7 Property Owner Belongings

Soil removal activities will be conducted to minimize, to the extent possible, damage to site property. Care will be taken not to damage on-site structures, vehicles, boats, etc. Structures (buildings, sidewalks, fences, etc.) and landscape features (trees, shrubs, etc.) damaged during the removal and replacement procedure will be repaired or replaced. If doubt exists whether damage was caused during the soil removal process, video and photographic documentation taken before initiation of activities will be reviewed on a case-by-case basis. The decision to repair disputed damages will be made by Asarco's project on-site coordinator.

4.0 SOIL STORAGE

Excavated soils will be transported to the following stockpile site:

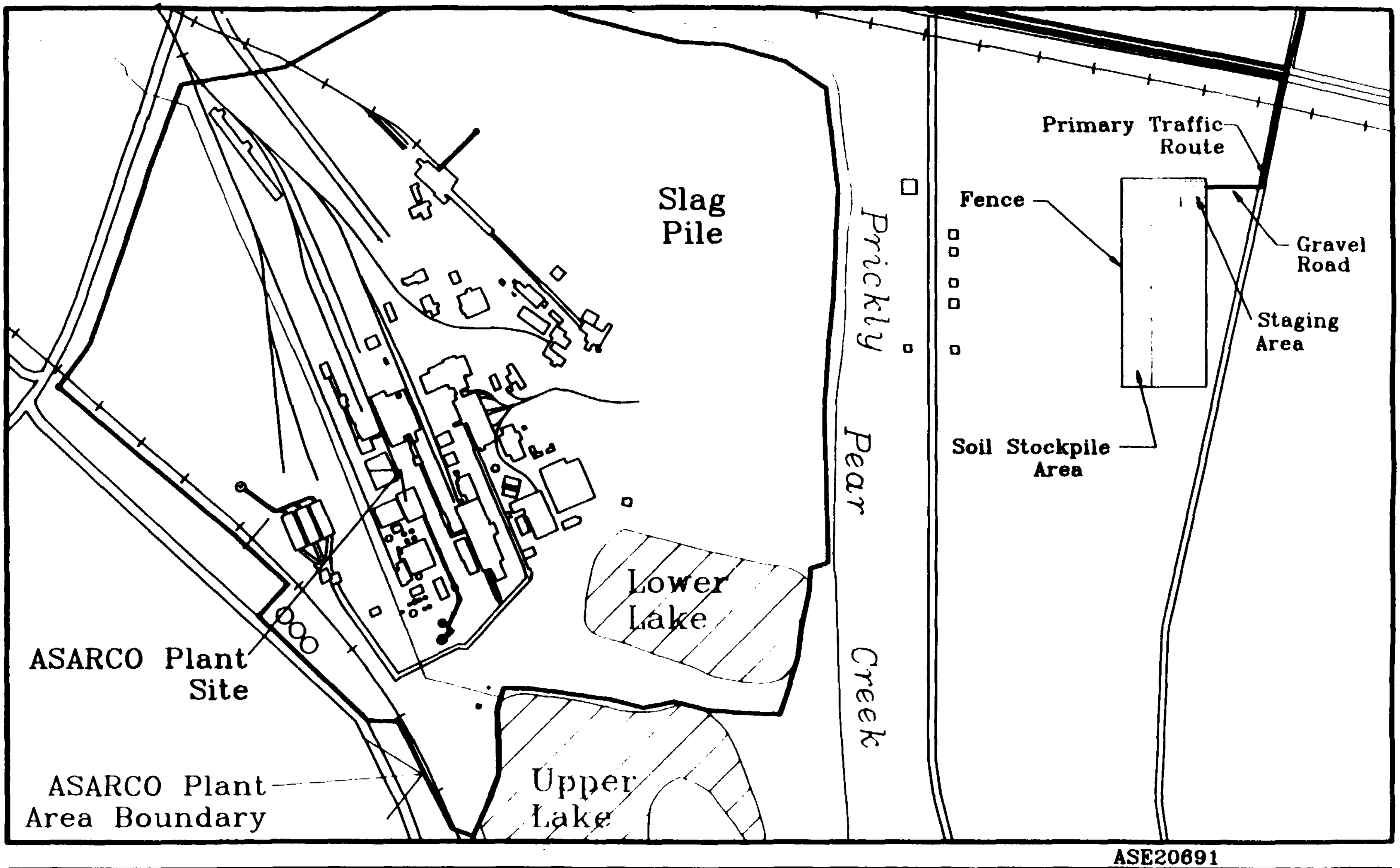
- East fields stockpile area,

The EPA has determined the east fields are an acceptable storage area for excavated soils until a focused feasibility study is conducted to determine the final soil disposal method.

Excavated soil will be transported by dump truck to the east fields, located east of the Asarco plant, and stockpiled in a 4.1 acre storage site (see Figure 4-1). Transportation routes from East Helena to the stockpile area will include U.S. Highway 12, Main Street, Montana Avenue and 1st Street (see Section 3.6.1). The potential stockpile area is located on Asarco property and access to the general public will be prohibited. The east fields 600 by 300 foot site will be fenced, and underlain with a 6-inch clay base to separate excavated soil from underlying indigenous soils.

4.1 STORAGE STRATEGY

A gravel road to the East Field storage facility will be constructed to minimize the potential of metals transport from haul truck traffic from the facility (see Figure 4-1). "Clean" gravel will be imported to construct the road. Haul truck traffic will be restricted to the constructed road to eliminate the potential of trafficking soil with elevated metals from the east fields. Trucks will place soil at a designated staging area as shown in



NORTH

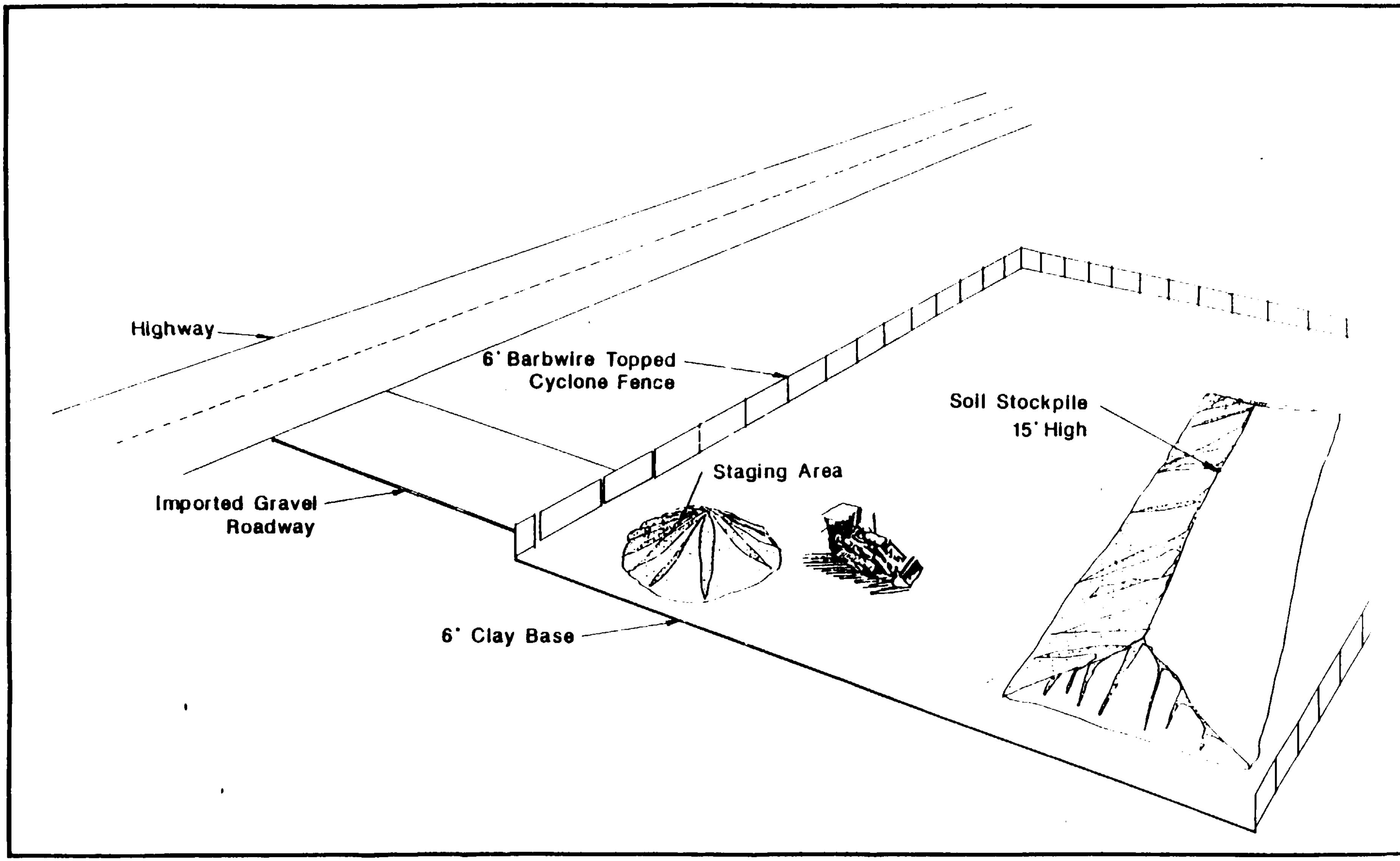
Scale: 1" = 500 feet

Figure 4-1. Proposed Soil Stockpile Location

Figure 4-2. From the staging area, soil will be moved to the stockpile by a front-end loader and a Caterpillar tractor.

4.2 DUST CONTROL

During soil moving operations at the stockpile site, the potential for dust will be minimized by mist spraying. Chemical fixatives such as Coherex or calcium sulfate may be applied to soil stockpiles to reduce the potential for transportation of airborne dust. A chemical or physical barrier will be placed over the stockpiled material at the end of each construction season. As stockpile areas are filled, excavated soils may be capped with imported "clean" soil and revegetated to establish a more permanent stabilization of the stockpiles. Permanent stabilization of excavated soils will be one of the alternatives examined in detail in the Focused Feasibility Study for the Location and Method of Disposal of East Helena Soils.



Not To Scale

Figure 4-2. Soil Disposal Activity Diagram

5.0 LONG-TERM IMPACTS

As a result of soil removal activities, long-term impacts include limitations on future land use, necessary implementation of institutional controls and long-term monitoring requirements.

5.1 FUTURE LAND USE

5.1.1 Storage Areas

As described in earlier sections in this work plan, excavated soils will be stored in the soils storage area; the east fields. The east fields are owned by Asarco and no future agricultural, residential or industrial uses are planned for this area.

5.1.2 Excavated Areas

This work plan addresses the community of East Helena only. Future uses of excavated areas are expected to remain similar to existing uses.

5.1.3 Areas Adjacent to the City of East Helena and Asarco Property

Based on data collected during the RI, some areas adjacent to populated East Helena have soils with elevated lead concentrations. The present use of most of these areas is agricultural. Occasional cattle grazing or raising hay crops for cattle feed are the primary land uses in these areas (RI/FS, 1990). Although the potential for changes in future land use are unknown at this time, it is possible adjacent areas could be subdivided for residential development. In the event future land use plans are developed, Asarco will cooperate in providing necessary information.

5.2 INSTITUTIONAL CONTROLS

Institutional control requirements for the East Helena area include fencing and continuing education. Public access to soil stockpile areas will be restricted by fencing as described in Section 4.0. Information on completed, on-going and future remedial activities, and site conditions will be provided through publications, news media, and public meetings. No additional controls are anticipated at this time. However, other potential institutional controls include:

- land use zoning to regulate future development in areas adjacent to East Helena that have elevated soil lead concentrations,

- building permit restrictions such as soil testing requirements in areas that have potentially elevated soil metal concentrations and have not yet been addressed by pre-removal sampling.

- Educate property owners regarding garden locations, if necessary.

5.3 LONG-TERM MONITORING REQUIREMENTS

Once the removal action within East Helena is completed, the exposure risk from the surface soil pathway will be greatly reduced. Long-term monitoring requirements include air quality monitoring and follow-up soil sampling.

Using the air quality monitoring network established in consultation with the EPA Air Program Branch and the Montana Air Quality Bureau (AQB) (see Section 4.0), the effects of potential aerial fallout and fugitive dust emissions from unremediated sources will be measured. Air quality samples will continue to be collected in accordance with protocol established by Asarco, the state AQB, and the EPA as described in the East Helena Project air quality QAPP (Hydrometrics, March 1989).

In addition to on-going air quality monitoring, a model of smelter stack emissions will be prepared to evaluate total element releases, and the potential for soil recontamination in removal areas. The model will be prepared using information and procedures develped for the new lead SIP (State Implementation Plan) modeling effort currently being conducted (CCP, April 1991). Several phases of modeling are being conducted as part of the SIP effort including: guideline complex terrain modeling, guideline simple train modeling for two monitoring stations (Hadfield and Firehall), chemical mass balance (CMB) modeling, and compliance modeling once dispersion and CMB models are fully developed and evaluated. Using the information developed as part of these SIP modeling efforts, the potential for future recontamination of remediated soil areas can be evaluated.

An annual sampling program to monitor the potential for reintroduction of metals in replaced soils will also be conducted. Annual monitoring will consist of soil sampling and analysis of selected representative yards and public areas where soils have been excavated and replaced. Based on documented post-removal soil sample activities, yearly monitoring samples will be collected from areas previously sampled during the post removal sample program. The annual sample collection and analysis protocol will be the same as the pre-removal and post-removal programs (see Sections 2.4 and 2.5). Approximately 5% of remediated residential yards, and 5% of remediated public park, school, playground and other properties will be sampled. Yearly sampling of road aprons and alley ways will be limited to a maximum of 1% of remediated areas.

6.0 RESIDENTIAL SOILS PERSONNEL AND PROJECT ORGANIZATION

The Residential Soil Remedial project organization and key personnel are shown in Figure 6-1. The general project organization schematic will be updated as additional personnel for the project are assigned. In addition, related documents (including the SAP and HSP) will include detailed project personnel, responsibilities and organizational information.

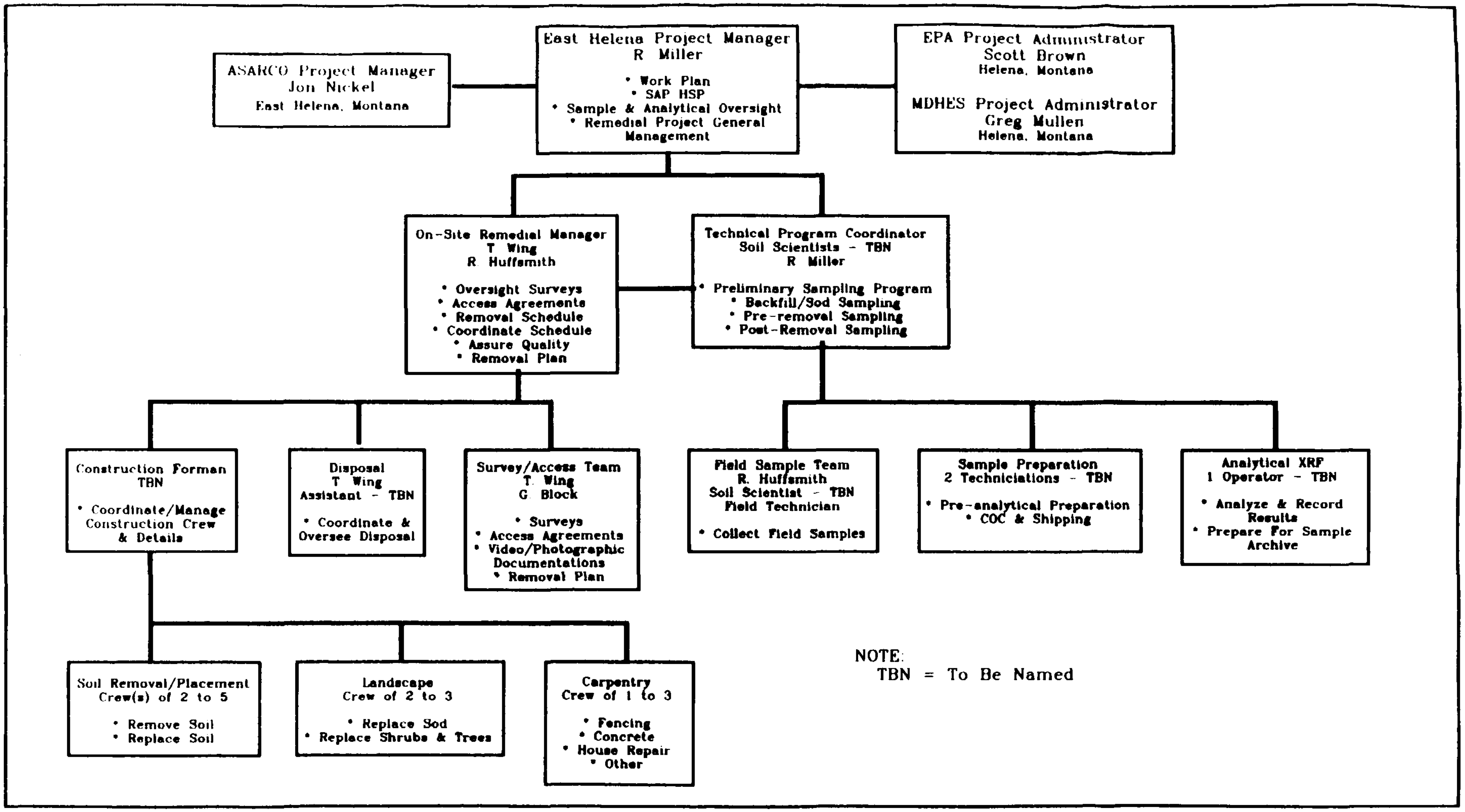


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Figure 6-1
General Personnel and Organization Chart for Residential Soils Excavation and Removal

7.0 REFERENCES

Anal. Chem., 1983, page 17.

Crock and Severson (1980), page 18.

Hydrometrics, 1989. Quality Assurance Project Plan for Air Quality Monitoring, Asarco, Inc., East Helena, Montana.

Hydrometrics, 1990, revised 1991 Comprehensive RI/FS, page 2.

Hydrometrics, 1991. Remedial Investigation/Feasibility Study for Residential Soils. March.

EPA, 1987. Phase I Soils Investigation, page 2.

CDC/MDHES study (1986)

1. XRF Calibration

One of the most common methods of calibration for XRF and the one that probably fits the East Helena situation best is based on the Lucas-Tooth and Price model. This is a linear multiple regression of the concentration value on various line intensities. The calibration only depends on standard concentrations for the analyte of interest and not on known concentrations for interfering elements. The calibration does not separate absorption from enhancement effects although it takes these into account to a certain extent. A single calibration for all of the East Helena soils may not be optimal for special subsets if the matrix effects vary widely. Nevertheless, if a single calibration is used then certain requirements of the calibration sample could help reduce the error at the critical value of 1000 mg/Kg lead. a) Restrict the sample range to a small symmetric interval (say 300) around 1000. b) Select a sample that has a mean near 1000. c) Ensure that the calibration is linear in the neighborhood of 1000.

The method can be written in compact notation as

$$\mathbf{y} = \mathbf{X}\mathbf{b} + \mathbf{e},$$

where $\mathbf{y}$ is a vector of standard (HF with AA) concentrations for lead, $\mathbf{X}$ is the matrix of k observed X-ray intensities plus all 1s in the first column, $\mathbf{b}$ is the vector of $k+1$ unknown regression coefficients, and $\mathbf{e}$ is the vector of i.i.d. normal errors with mean 0 and variance σ^2. Let N be the number of samples and thus the number of rows in $\mathbf{y}$, $\mathbf{X}$, and $\mathbf{e}$. Of course, the usual least squares estimation is

$$\hat{\mathbf{b}} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{y}.$$

The error variance can be estimated as

$$\hat{\sigma}^2 = \frac{1}{N-k-1}\mathbf{y}'[\mathbf{I} - \mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}']\mathbf{y}.$$

The multiple correlation coefficient is calculated as

$$R = \sqrt{(\hat{\mathbf{b}}'\mathbf{X}'\mathbf{y} - N\bar{y}^2)/(\mathbf{y}'\mathbf{y} - N\bar{y}^2)}.$$

We can now estimate an upper or lower confidence bound for the calculated value y, given a particular set of intensities, $\mathbf{q}$, as

$$\mathbf{q}'\hat{\mathbf{b}} \pm \hat{\sigma} t_{N-k-1}(\alpha)\sqrt{\mathbf{q}'(\mathbf{X}'\mathbf{X})^{-1}\mathbf{q}}.$$

The above formula shows that the confidence bounds depend on the particular intensities and are not unique for a given y concentration value. This is intuitively clear since the quality of the calculated result varies with different matrix effects. Treatment of this variation as part of the random system can be accomplished by considering the simple linear relationship of XRF calculated values vs. standard AA concentrations.

2. Evaluation of XRF Method

If we have calibrated the XRF as in the above section using multiple regression, then the coefficients will be such that the sums of the squares of the differences between the calculated values and the standard values will be a minimum. This means that if we plot the XRF calculated values vs. the standard values we will have points scattered about the line $x = y$. In this notation x is the calculated XRF value and y is the standard concentration. We can use the obvious methods of assessing the quality of the XRF value by calculating

$$S = \sqrt{\frac{1}{N-k-1}\sum_{i=1}^{N}(x_i - y_i)^2}.$$

If these points are confined to a small interval about 1000 then a good approximation for the lower 95% confidence bound is

$$L95 = 1000 - St_{N-k-1}(.95)\sqrt{1 + \frac{1}{N}}.$$

This corresponds to the simple linear regression confidence bound for predicted value of y if the mean of the concentrations is near 1000.

APPENDIX 1.

XRF CALIBRATION PROCEDURE AND CALCULATION OF CONFIDENCE LIMITS

APPENDIX 2.

SURVEY FORMS

BLOOD-LEAD SCREENING PROGRAM
OUTREACH CENSUS

NAME: ______________________
ADDRESS: ______________________
P.O.BOX: ______________________
East Helena, MT. 59635
PHONE: ______________ (H) ______________ (W)

Q-1 How many people currently reside at this address?

____

Q-2 Are there women living at this address who are pregnant, nursing, or who are considering pregnancy?

1) YES -- Please list the person's name and indicate whether they are pregnant, nursing, or are considering pregnancy. [Name(s) optional, will remain private and confidential]

____

____

2) NO

Q-3 Are there any children living at this address?

1) YES -- Please list the child's name and age:

____

____

____

____

____

____

2) NO

If you answered YES to at least one of the questions above, you are eligible for prize drawings if you participate in the blood-lead screening. Our clinic is located at #2 South Morton, just west of Smith's Place on Main Street in East Helena. Clinic hours are Monday through Friday (1:00 p.m. to 7:00 p.m.). Please call 227-6252 to make an appointment or if you have any questions concerning the blood-lead screening.

Please return this form as soon as possible by either stapling or taping it together and putting it in the mail. Postage and the return address are affixed on the back of the form for your convenience in returning it. All information will remain private and confidential.

Thank you very much,

Ed Thamke
Lewis & Clark County Health Department
East Helena Blood Lead Study

ET/jm

East Helena Blood-Lead Questionnaire

Client# ____ ___ _____   Name ______________________   Sex ___   Age _______
Months ____

Street ____________   Time spent playing outside ____________   Locations playing outside ____________

City ____________   State ____________   Zip Code ____________

Home Location ____

Age of Home ________   Time spent at home ______   Pica Habits ________

Parents Name:	Occupation:	Pets:
____________	____________	____________
____________	____________	____________

Smoker in the home?   Yes ___   No ___

Has home been remodeled recently?   Yes ___   No ___

Does individual take supplemental vitamins?   Yes ___   No ___

Do any of the following activities take place in individuals home:

- Paint pictures?   Yes ___   No ___
- Paint furniture?   Yes ___   No ___
- Stain glass?   Yes ___   No ___
- Cast lead into bullets or fishing sinkers?   Yes ___   No ___
- Work with soldering on electronics?   Yes ___   No ___
- Work on soldering pipes?   Yes ___   No ___
- Make pottery at home?   Yes ___   No ___
- Ride dirt bike or ATU?   Yes ___   No ___

Other Information/Comments:

____

____

____

QUESTIONNAIRE
FOR PRIORITIZING SOIL REMOVAL ACTIONS
IN EAST HELENA

The purpose of this questionnaire is to assist Asarco in determining the sequence of soil removal actions in East Helena. Priority will be given to those households having small children or expectant mothers. Public areas and commercial property will receive lower priority ratings. Based on survey results and soil lead concentrations, residences, public areas and other areas will be ranked in decending priority to help schedule the soil removal actions.

Resident: ______________________________

Street Address: ______________________________

P.O. Box: ______________________________

_____ Yes _____ No 1. Resident lives in the yellow zone.

_____ Yes _____ No 2. Pre-removal soil sampling shows soil lead concentrations greater than 1000 mg/kg.

_____ Yes _____ No 3. Residence has children under 6 or expectant mothers.

_____ Yes _____ No 4. Resident wants to have property prioritized for eventual soil removal (removal consent will come at a future date, dependent on the property's priority rating).

_____ Yes _____ No 5. Are there any fixed structures (fences, buildings, statues ...) 50 years old or more?

Interviewer's signature: ______________________________

Date: ______________

YARD SPECIFIC SURVEY
FOR SOIL REMOVAL ACTIVITIES

Resident ______________________________

Street Address ________________________

Residential Lot (___'x ___')

City Street

Instructions for yard specific characteristics (describe and locate on map)

1. Yard areas that you do <u>not</u> want to be sodded -

   A. Parking areas for recreational vehicles:

   B. Garden area:

   C. Flower beds:

   D. Other areas:

2. Which trees and shrubs can stay and which can be removed?

YARD SPECIFIC SURVEY
FOR SOIL REMOVAL ACYIVITIES

3. Does the property have structures with dirt floors?

4. Special considerations - does the property have septic tanks, underground sprinklers, well casings, etc.?

5. Will you be able to have the yard free of obstructions when the soil removal is to take place?

6. Will you be initiating your own home improvement activities during the soil removal that will need to be coordinated with the contractor, i.e., pouring concrete, installing sprinkler systems, etc.?

7. Other considerations: